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The River and Harbor bill, as now before Congress, calls for an expenditure of $20,700,000 in the coming fiscal year; $1,907,000 more than the bill reported in April, 1890. Among the chief items of work authorized to be done, but for which future appropriations will be required, are the following: Hudson River improvements, $2,197,906; harbor of refuge at Point Judith, R. I., $1,075,000; for a 21-ft. channel through the lakes, from Duluth to Buffalo, $2,840,000; Charleston harbor, $1,878,000; Savannah harbor, $2,792,000; Mobile harbor, $1,093,800; Columbia River, Ore., to the Cascades, $1,310,500; Mississippi River, St. Paul to the mouth, $12,700,000. These items, added to the present bill and present contract liabilities, swell the total of public works now authorized to $46,437,206. The bill recommends the expenditure of $6,470,000 in the next fiscal year on the work above outlined, $4,000,000 of this to go to the Mississippi River. The remainder of the bill appropriates sums ranging from $1,000 to $300,000 for a multitude of river and harbor improvements, scattered all over the states.

A territorial irrigation convention was held at Las Vegas, N. Mex., March 16 and 17. Resolutions were adopted favoring the cession of arid lands to the several states and territories, with the understanding that the lands be reclaimed by irrigation. At the opening of the convention, 186 delegates were present. E. S. Stoner, of Albuquerque, was Chairman, and J. H. Crist, editor of the Santa Fe "Sun," was Secretary.

The Austin dam, Texas, cableway, before noticed by us as the longest single span of wire cable way in the world, i. e., 1,350 ft., we find not to be such. In our issue of March 21, 1891, we described two still longer spans, 1,378 and 1,935 ft., at Plomosas, Sinaloa, Mexico. The Austin cable has now been in use nearly a year. The contractor, Mr. B. Corregan, writes that every feature of the plant (put in by the Lidgerwood Mfg. Co.) works well, and that he easily handles loads of seven to eight tons on this span of 1,350 ft. at a speed of from 600 to 800 ft. per minute. The main cable is 2 1-2 ins. in diameter, and the hoisting rope is 1 3-4 ins. in diameter.

A filter plant of horizontal sectional washing filters has been erected by the New York Filter Co., at San Leandro, Cal., for the Contra Costa Water Co., to supply the city of Oakland. This plant was put in operation May 23, 1891, and has a guaranteed capacity of 4,000,000 gallons of water per 24 hours. It consists of nine filters of the Hyatt pattern, 8 ft. diameter by 18 ft. long, and provided with the company's patented cone valve outlet system, and so constructed that the filtering material can be violently agitated, scoured, rinsed and cleansed by directing the maximum force of the current of water against sections of the bed alternately. The water supply of Oakland is said to be exceedingly turbid during the rainy season, and through the summer months to carry excessive quantities of algae.

The net earnings of railways in the United States for the months of January show a decrease of 6.15 per cent. from corresponding figures for the same month of 1891, according to the "Financial Chronicle." This result is largely due to the unfavorable weather, and the small cotton movement. The following table gives the net earnings of 126 roads by sections or groups:

Sections or Groups.	Net Earnings. 1891.	1892.	Inc. or Dec. P. C.
Trunk lines, (11)	3,494,060	$3,009,844	— 13.86
An. Coal, (6)	818,361	827,792	+|- 1.15
Middle States, (13)	371,674	354,002	— 4.59
Middle Western, (23)	1,036,245	957,672	— 7.58
Northwestern, (13)	1,566,448	2,028,240	+|- 29.58
Southwestern, (11)	1,405,571	1,599,363	+|- 13.79
Pacific Coast, (20)	3,344,871	2,970,271	— 11.19
Southern, (27)	1,909,205	1,395,561	— 29.11
Mexican, (2)	316,742	298,708	— 5.69
U. S., (126)	14,323,177	13,442,051	— 6.15

Only three groups show increases, and in one of these, the Anthracite Coal, the increase is only nominal. The Northwest and Southwest exhibit very good results, but the other groups all have decreases of considerable amounts. The Southern roads have an especially unfavorable exhibit, only 6 roads of the 27 show gains over last year's figures.

Contracts for pumping the water from Lake Angeline, Mich., are reported in a press dispatch from Ishpeming Mich., as having been awarded to B. C. Howell, New York city. The greatest depth of the lake is said to be 43 ft., and its capacity is estimated at 180,000,000 gallons. Beneath the lake is a bed of ore owned by the Cleveland Iron Mining Co., the Lake Erie Mining Co. and the Pittsburg & Lake Angeline Co.

The necessary candle-power of signal lights for use in marine service as anchor and running lights has been investigated by a committee of the U. S. Light-House Board. It was found by experiment that at a distance of 1 mile white light of 1 c. p. is clearly visible, and red and green lights of 3.2 c. p are fairly visible. At 2 miles, white light of 2 c. p. is clearly visible, and red and green lights of 29 and 28.5 c. p., respectively are clearly visible. The problem of determining the least candle-power at which lights of various colors can be clearly seen at definite distances is not capable of a rigorous solution; for the eyesight of different observers varies, and the nature of the atmosphere on different nights, apparently clear, considerably influences the range of visibility. Also, in the case of colored lights, the amount of absorption would increase with the density of the color of the glass.

Taking all these facts into consideration, the committee recommended the following candle-powers for different colored lights as the lowest which can be used and give a proper margin of safety:

	Candle powers at: 1 mile.	2 miles.	5 miles.
White lights	1	2	30
Red or green lights	4	40	—

The most serious railway accident of the week was a derailment March 21 near Findlay, O., on the Findlay, Fort Wayne & Western R. R. The engine, tender, two passenger cars and a baggage car were wrecked, and 8 persons were seriously injured; 2 of them fatally. The accident is said to have been caused by a broken rail.—A serious crossing collision occurred at Odin, Ill., March 23, in which 17 persons were injured, but none seriously. The Illinois Central R. R. crosses the Ohio & Mississippi R. R. at this point, and a freight train on the former line ran into a passenger train on the latter, wrecking a passenger car and the front end of a sleeping car. The engine driver of the Illinois Central train claimed that his train had got beyond control. Such crossing collisions, of course, are chiefly due to the lack of proper interlocking plant.

A timber trestle on the Southern Pacific Ry., near Sanderson, Tex., caught fire March 16, and 8 cars of a freight train went through and were burned.

A section of the wall of Reservoir No. 2 of the Leavenworth Water Co., Leavenworth, Kan., gave way March 12, letting out 7,500,000 gallons of water, which did considerable damage to the railway tracks between the reservoir and the river. It is stated that the city's water supply was not affected.

A broad patent covering the transmission of electrical energy by alternating currents and transformers has just been issued to Marcel Deprez and Julius Carpentier, of Paris. Claim I. of the patent reads:

The improvement in the art of transmitting electrical energy to and utilizing it at a distance from the source, which consists in generating maintained and practically uniform currents of high tension at one station, and sending the same over a line of conductors to another station and generating maintained and practically uniform currents of lower tension at the second station by the inductive influence of the high-tension currents, substantially as described.

The issuance of this patent has been delayed by an interference proceeding which has been for some years pending between the above application and those of Alexander Bernstein, Rudolph M. Hunter, of Philadelphia, and the Gaulard & Gibbs patent, owned by the Westinghouse Electric Co. Should the courts sustain the broad claims of the Deprez patent, the effect on the progress of alternating current apparatus may be far reaching. It is stated that a syndicate of European capitalists controls the patent and intends to test its validity at once. It should be said, however, that in any event, the patent will expire in three years, or on April 5, 1895, as the same invention was patented in France April 5, 1881.

Immigration is now going on at a rapid rate; 44,125 in the first two months of 1892, against 33,876 in 1891. The increase is almost wholly in the worst classes, from Russia and Hungary, with some increase from Germany, and about the same from all other countries. Italy, Russia and Hungary now furnish about half of our immigrants. Fortunately, the recent tendency to an inferior grade of immigrants is attracting general attention, and there is likely to be some legislation on the subject after the presidential election, if not before.

Oil is apparently to be used instead of coal under the furnaces at the World's Columbian Exposition. The lowest bid for coal was $2.44 per ton, while the Standard Oil Co. offered a 42-gallon barrel of oil for 70 cts. As this company claims that three barrels of oil are equivalent to one ton of coal in heat-giving qualities, the oil is cheaper than the cheapest coal, and the management favors the oil provided it can get it for 70 cts. per barrel until 1893, and thereafter at the lowest market price, not exceeding 72 1-2 cts. per barrel. The lowest estimate made of coal required is 75,000 tons, and on this basis at least 225,000 barrels of oil would be wanted; probably the largest quantity ever sold to one consumer.

The disposal of city refuse is no more profitable in Edinburgh than in other large cities, notwithstanding the glib talk of some who find great profit—theoretically—in disposing of it to farmers. The Edinburgh Councils lately sent out 1,521 circulars to farmers in their vicinity, inviting tenders for about 51,900 tons of refuse and manure, or about one-half of the yearly product. Only 47 tenders came in, and these under conditions that practically required the city to pay all expenses of transport, and even, in some cases, to pay the farmers so much a ton for accepting it.

The Vyrnwy Aqueduct tunnel, under the Mersey, according to the report of Engineer Deacon, of Feb. 23, had 640 ft. completed out of a total of 805 ft. for the river portion. In the preceding week 24 lin. ft. of tunnel was driven and lined. The tunnel is now in a sand formation, and a "blow-out" on Feb. 18 occasioned some delay. Clay is being dumped in on the river-bed to consolidate the material in front of the shield and air-pressure is being used in connection with this work.

An improvement in signal lights has been introduced by the Midland Ry., of England. Instead of red, green and white lights, with a white or a green back-light, only two colors will be used. The red light will indicate "danger," and show to the signalman a white back-light. The green light will indicate "track clear," and the back-light will be obscured. Many accidents and mistakes are said to have been made in consequence of green back-lights being mistaken for green signals. As red and green are now to be the only signals, a white light shown to a driver will indicate a signal out of order, to be treated as danger.

An electric railway, about 2 1-2 miles long, is to be built by the Hobart Tramway Co., Hobart, Tasmania, and the electric system will be adopted on all the company's lines, a total of 8 1-2 miles. It is also proposed to contract for the electric lighting of streets and buildings. The overhead trolley wire system will be adopted for the railway, and a contract has been made with Siemens Bros. & Co., of London, for the electrical equipment of the lines, and 20 cars, at $165,000, and for the operation of the line until December, 1893, at 8 cts. per car mile, earning not less than $5,000 per month, including wages of conductors and drivers. The fare will be 6 cts., and the speed is limited to 12 miles per hour. Freight may be carried at the rate of 25 cts. per ton per mile. The city has a population of 38,000.

The Liverpool, England, water-works now supply a population of 760,000, with an average of 24 1-4 gallons per day per head. The service is constant as a rule. The pressure in the mains, in the warehouse district, varies from 50 to 80 lbs., and is seldom less than 70 lbs. along the docks. Until the Vyrnwy works are in use the Corporation depends for water upon 6,500,000 gallons daily pumped from deep wells in the red sandstone near Liverpool, and 12,000,000 gallons daily taken from a watershed of 10,000 acres near Bolton and Blackburn. The cost of pumping from the deep wells, in 1890, varied from 0.21 to 0.42 penny (0.42 to 0.84 cts.) per 1,000 gallons lifted 100 ft. high.

THE BOOTH IMPROVED DREDGE PUMP.

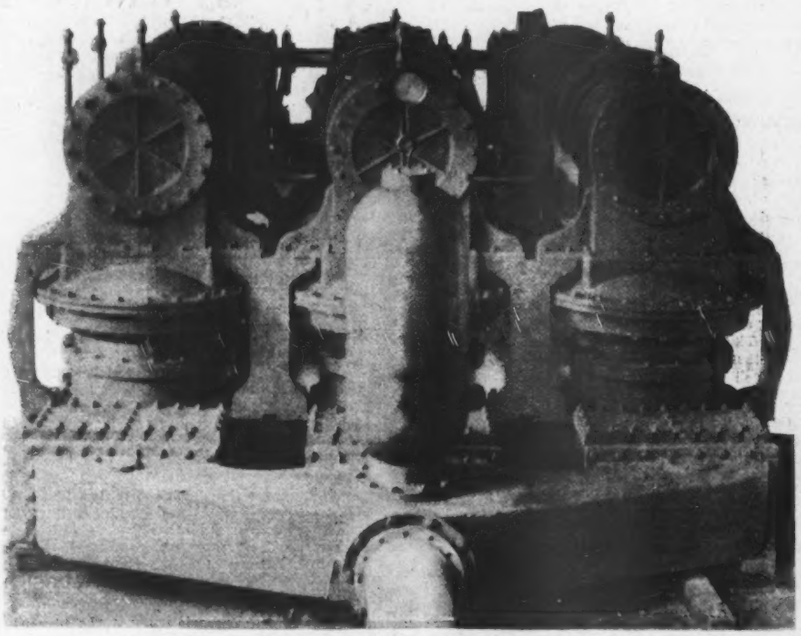
The pump here first illustrated and described owes its origin to an effort on the part of its inventor, Mr. C. H. Booth, to raise economically the level of a large tract of land lying below high-water mark on the upper Mississippi River. After several years spent in experiments with various vacuum, siphon and centrifugal pumps and dipper dredges, he devised the machine now described, practically a new departure in appliances for dredging and moving sand and other materials considerable distances.

This pump, now in successful operation for some time, is clearly shown in the accompanying cuts. It consists, essentially, of three externally packed, double acting, plunger pumps operated directly by three steam cylinders. The piston rods extend through and are connected to a three-throw crank shaft, thus securing that perfectly uniform and continuous movement, so essential in sand pumping.

Each pump cylinder has two hollow chambers of a spheroidal form, attached at each end, each of these chambers being provided with a flexible diaphragm of rubber or other suitable material. These diaphragms are molded in a semi-spherical shape so as to have a capacity in their full movement, or pulsation, equal to or slightly exceeding that of one stroke of the corresponding pump cylinder. This gives the cylinder its full amount of liquid material, up to its capacity, without strain upon the diaphragm. To the diaphragm chambers are attached the valve-chests, and each valve-chest is divided in the center by a partition forming a perfectly straight and unobstructed passage for each end of the pump cylinder.

In operation the plunger in each pump is first moved to one end of the stroke and the entire space between the plunger and the nearest flexible diaphragm is then filled with clean water. The plunger is then moved to the other end of the stroke and the corresponding space filled in like manner. The pump is now ready for working, and the motion of the plunger acting on the contained liquid communicates a corresponding action or inversion to the diaphragms.

The movement of the diaphragms causes a suction and discharge of material in the valve chests, the chamber is divided into two passages by means of a partition running the whole length of the chamber with each passage provided with separate inlet and outlet valves. Each end of the pump cylinder is thus connected to a different passage, thus drawing in the fluid material at the inlet valve of one of the passages and discharging a corresponding volume at the outlet valve of the other passage at each stroke of the piston. It should be distinctly understood that the two valve chests are entirely separate from each other. Each stroke of the pump piston charges one passage or chest, and discharges from the other fluid material drawn into it on the preceding stroke.

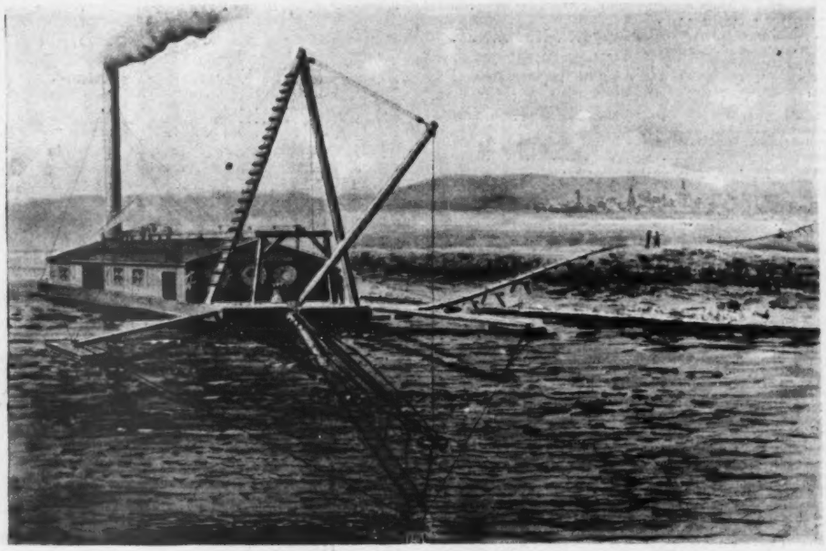


END VIEW OF BOOTH'S DREDGE PUMP.

whole of the material moved being separated from the pump cylinders by means of the diaphragms. The diaphragms pulsating in equilibrium are free from strain or tendency to rupture and will last for months without renewal.

The arrangement of the valve-chambers is somewhat peculiar and the small diagram is given to make this more plain. As there shown, each valve,

The view of the dredge pump in operation shows the suction pipe which is attached to the pump by a flexible connection and is held in suspension by a trussed boom attached to a frame on the deck of the boat. In operation the suction pipe, which is about 60 ft. long, is lowered until it comes in contact with the bottom of the river. The suction of the pump immediately draws the sand and other material up the inclined suction pipe with the water; at the same time the mouth of the suction pipe is moved around in a semi-circle by means of the attached lines leading to the ends of the booms and actuated by the power winches at the stern. The suction pipe on the completion of its circuit is again lowered and the movement reversed, and in this way a sweep or swath of from 100 to 180 ft. is made until the proper depth is attained, when the boat is moved sufficiently to make a new cut.



SKETCH SHOWING DREDGE IN OPERATION.

For pumping clay and other hard material, a cutter and stirrer is provided, which is very ingeniously operated by means of wire rope running over a series of sheaves so arranged that the movement of the suction pipe does not interfere with the perfect working of the stirrer. The power to operate the stirrer, as well as to move the suction pipe, is derived from the pump itself and is all under the control of the engineer in charge of the pump.

Some of the advantages of combined plunger pumps for suction dredging, as exhibited by Booth's patent double acting triplex pump, are thus set forth by the inventor:

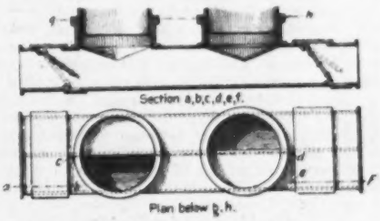
1. A continuous uniform suction is obtained by the combination of three double plungers, all connected to cranks on the same shaft. 2. The cranks are set at such angles to each other as to make the aggregate movement of the plungers uniform. 3. There are at least two of the six plungers forcing and two sucking at any period of time while the pump is in motion. 4. Each plunger carries within itself its own air chambers. 5. To convey material pumped to a dumping locality at any reasonable distance and elevation is not dependent on gravity, but only on applying the requisite power. 6. The material heavier than water and mixed with it is brought within the inlet valve of the pump through an inclining suction pipe with much greater facility than through a vertical pipe. 7. The combination of three or more double plunger pumps is necessary to successful dredge pumping. 8. The inlet and outlet valves being in valve chests located only about 1 ft. above the surface of the water, the atmospheric pressure is only utilized to elevate the material pumped to that limited height. 9. There being an unobstructed passage through pipes and pump of at least 8 ins. square, any solid body of less dimensions will pass through without injury to the pump. 10. There is no expensive power and machinery used to prepare material to be pumped. 11. There are no strainers necessary over the mouth of the suction pipe. 12. A simple cutter or stirrer is used under the mouth of the suction pipe when it is needed to displace or loosen solid material so firmly imbedded in place as to resist the suction pressure. 13. The power required to operate the cutter is taken directly from the pump shaft, and is transmitted to the former

from the latter by means of a wire cable in such manner as to work the cutter at any required vertical or lateral angle. 14. The movement and handling of the suction pipe is directly under the control of the engineer by means of simple machinery driven by the pump shaft. 15. The several plungers working in cylinders filled with clean water separated from the gritty mixture by semi-spherical diaphragms are readily kept air tight by the operator or engineer attending to the stuffing boxes while the pump is in operation.

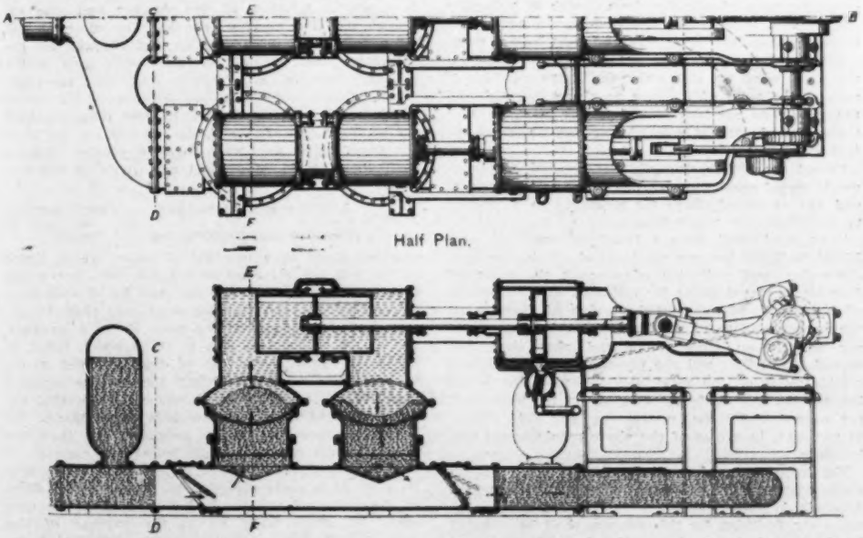
While the chief use of this pump will be undoubtedly in the direction of dredging from the bottom over which the machine floats, Mr. Booth also proposes to use it for the removal of islands by attacking them at the base and undermining them. It is believed that it can also be utilized as a "gold-hunter" in rivers where deposits of fine gold exist at the bottoms of sand-bars. The inventor believes that depths of even 50 ft. could be reached and the sand raised by this dredge. The rich sand lifted could be discharged with the water over grooved aprons of large dimensions, and the usual steps taken for securing the gold. The heavier gold, often found at the bottom of these deposits, could be taken up by the suction pipe and deposited in a cavity in the pipe prepared for that purpose.

We are indebted to Mr. F. Thornely, of the Novelty Iron Works, of Dubuque, Iowa, for the material here used, these works having built the machine now in use. They are now engaged in constructing two other like machines.

We have no record of the actual performances of this pump dredge other than that its operation has led to the building of two more dredges on the same system, and the incidental mention that the work is done for about one-fifth of the price of removing the same material by other dredging methods. The inventor has not sought to bring his system before the public until it was thoroughly perfected and secured by letters patent. He is now satisfied as to these points, and, at our request, here first illustrates and describes it. We understand that Mr. Booth believes that his dredge pump would be of great service in government operations, that it would save much money, and the right to use it should be owned by the government.



Sketch of Empty Valve Chest to Show Connection of Diaphragm Chambers each with Separate Half of Valve Chamber



THE BOOTH DREDGE PUMP.

WORLD'S COLUMBIAN EXPOSITION.

Specifications for Construction Materials and Workmanship.

In the present article we abstract at considerable length the general specifications for the materials and workmanship of the buildings. These specifications are issued by the Bureau of Construction, and they are of interest as they represent the latest compilation of specifications for structural material, and are for a decidedly unique class of work.

The general conditions forming a part and parcel of all specifications state that general and working drawings showing material and principal dimensions will be furnished by the Bureau of Construction, except for iron work, for which general drawings only will be furnished. For this work the working drawings must be approved by the Consulting Engineer before work is commenced, but such approval will not relieve the contractor from liability for any loss or damage that may possibly result from his omission, neglect or refusal to promptly notify the Chief of Construction of any defect in plan or material, or of any error or miscalculation, or of any circumstance which in the contractor's opinion tends to render the work unsafe. This applies also to all general plans furnished by the Bureau of Construction, and is intended to provide that the contractor shall not be authorized, by reason of the approval of the plans and specifications by the Consulting Engineer, to ignore or neglect to report to the Chief of Construction any imperfections in plan, material or workmanship. On such a report being made, that part of the work so criticised must not proceed until the contractor has received a written order from the Chief of Construction directing what is to be done and how he is to proceed.

The decision of the Chief of Construction shall control as to the interpretation of drawings and specifications, and as to the material and workmanship, and his decision is to be final and binding. The Chief of Construction reserves the right to make any changes in the plans and specifications that he may deem desirable. Should any additional labor or material be involved in such changes, the contractor shall be paid for supplying the same; while should such changes reduce the amount of labor or material in the structure as designed, the contractor is to sustain an equivalent reduction in his contract amount. The Chief of Construction is to be the sole arbiter in determining rates of increase or reduction, and no claim for extra labor and material above the contract amount will be allowed unless ordered in writing by him. Each contractor is to furnish all false-works, tools and appliances and remove all materials and debris after the erection. He is to be responsible for the work until finished and accepted, and responsible for accidents; must maintain all requisite lights, guards, fences, etc., and is to observe all laws and city ordinances, and comply with the rules and regulations of the exposition management and Bureau of Construction. Contractors are not to employ any but native born or naturalized citizens, or persons who have in good faith declared their intentions of becoming citizens. The Chief of Construction reserves the right to require the removal of any workman or workmen. A day's work is to be eight hours on the grounds.

All royalties for patents or for infringement thereof that may be involved in the erection or use of the buildings shall be included in the contract amount .f ascertained, and the contractor is to satisfy all demands that may be made, and be liable for damages for infringement. Should the preparation of the material for the structure be widely distributed or should unnecessary delays occur in getting out the same, or in the required date of final completion, the cost of extra inspection shall be borne by the contractor, the Chief of Construction being sole judge of what is to be deemed extra inspection. No part of the work on the buildings is to be sublet without the approval in writing of the Chief of Construction. All drawings and specifications are to be preserved and returned to the Chief of Construction before the certificate of final settlement is issued. The management will run a supply pipe to a point convenient to the buildings, and supply all the water necessary for the construction of the same. The contractor is to keep the work and materials insured against loss by fire in favor of the management.

In regard to estimates it is provided that the Chief of Construction, or his authorized assistant, will make monthly estimates of the work erected, and 85 per cent. of the amount of the estimate will be paid on or before the 15th of the month following the month in which the work was done. The remaining 15 per cent. to be paid within 40 days after the completion and acceptance of the whole work included in the contract. No payment will be made on material not erected in place, and no oversight or error in the making of estimates or certificates shall relieve the contractor from his obligations to do and complete the work according to the true intent of the drawings and specifications. Provisions are also made for retaining money to pay any liens or charges not discharged by the contractor, and for the rescinding of the contract. The Chief of Construction may require the contractor to employ more men, tools and machinery upon the work. A deduction from the contract price is to be made, as liquidated damages and not as a forfeit, for each day the completion of the work is delayed after the specified date, unless an extension of time has been granted by the Chief of Construction. Each contractor must, at an early date, put himself in communication with other contractors whose work may affect his, so as to promote harmony of work, any difference of opinion being arbitrated by the Chief of Construction or his authorized agent. The usual requirements are made for submitting bids, furnishing bonds, etc.

Specifications for Wrought Iron.

All wrought iron must be tough, ductile, fibrous, and of uniform quality for each class; straight,

smooth, free from cinder pockets or injurious flaws, buckles, blisters, or cracks. As the thickness of bars approaches the maximum that the rolls will produce, the same perfection of finish will not be required as in thinner ones. No specific process or provision of manufacture will be demanded, provided the material fulfills the requirements of this specification.

The tensile strength, limit of elasticity, and ductility shall be determined from a standard test-piece, not less than 1-4 in. thick, cut from the full-size bar, and planed or turned parallel; if the cross-section is reduced, the tangent between shoulders shall be at least twelve times its shortest dimension, and the area of minimum cross-section in either case shall not be less than 1-4 sq. in. and not more than 1 sq. in. Whenever practicable, two opposite sides of the piece are to be left as they come from the rolls, but the finish of opposite sides must be the same in this respect. A full-size bar, when not exceeding the above limitations, may be used as its own test-piece. In determining the ductility, the elongation shall be measured, after breaking, on an original length the nearest multiple of 1-4 in. to ten times the shortest dimension of the test-piece, in which length must occur the curve of reduction from stretch on both sides of the point of fracture, but in no case on a shorter length than 5 ins.

All iron to be used in the tensile members of open trusses, laterals, pins and bolts, except plate iron over 8 ins. wide, and shaped iron, must show by the standard test-pieces a tensile strength in lbs. per sq. in. of:

$$52{,}000 - \frac{7{,}000 \times \text{area of original bar}}{\text{circumference of original bar}} \text{ (all in inches),}$$

with an elastic limit not less than half the strength given by this formula, and an elongation of 20 per cent.

Plate iron 24 ins. wide and under, and more than 8 ins. wide, must show by the standard test-pieces a tensile strength of 48,000 lbs. per sq. in., with an elastic limit not less than 26,000 lbs. per sq. in., and an elongation of not less than 12 per cent. All plates over 24 ins. in width must have a tensile strength not less than 46,000 lbs., with an elastic limit not less than 26,000 lbs. per sq. in. Plates from 24 ins. to 36 ins. in width must have an elongation of not less than 10 per cent.; those from 36 ins. to 48 ins. in width, 8 per cent.; over 48 ins. in width, 5 per cent.

All shaped iron, flanges of beams and channels, and other iron not hereinbefore specified, must show by the standard test-pieces a tensile strength in lbs. per sq. in. of:

$$50{,}000 - \frac{7{,}000 \times \text{area of original bar}}{\text{circumference of original bar}}$$

with an elastic limit of not less than half the strength given by this formula, and an elongation of 15 per cent. for bars 5-8 in. and less in thickness, and of 12 per cent. for bars of greater thickness. For webs of beams and channels, specifications for plates will apply.

The shearing strain per sq. in. on iron rivets and pins shall not exceed 8,000 lbs.; and the pressure on the projected semi-intrados of the rivet and pin holes must not exceed 15,000 lbs. per sq. in. Extreme fiber strain for pins must not exceed 20,000 lbs. per sq. in. For field rivets 25 per cent. in excess of the above requirements will be made. All plates, angles, etc., which are to be bent hot in the manufacture, must, in addition to the above requirements, be capable of bending sharply to a right angle at working heat without sign of fracture.

All rivet iron must be tough and soft, and pieces of the full diameter of the rivet must be capable of bending cold until the sides are in close contact without sign of fracture on the convex side of the curve. All iron to be used in the tensile members of open trusses, laterals, pins and bolts, except plate iron over 8 ins. wide, and shaped iron, must bend cold, 180 degrees without sign of fracture, to a curve, the inner radius of which equals the thickness of the piece tested. Specimens of full thickness cut from plate iron, or from the flanges or webs of shaped iron, must stand bending cold, through 90 degrees to a curve, the inner radius of which is 1 1-2 times its thickness, without sign of fracture.

For each contract, four standard test-pieces and one additional for each 50,000 lbs. of wrought iron, will, if required, be furnished and tested by the contractor without charge, and if any additional tests are required by the purchaser, they will be paid for at the rate of $5 each; or, if the contractor desires additional tests, they shall be made at his own expense under the supervision of the purchaser, the quality of the material to be determined by the result of all the tests in the manner set forth in the following clause:

The respective requirements stated are for an average of the tests for each, and the lot of bars or plates from which the samples were selected shall be accepted if the tests give such average results, but if any test-piece gives results more than 4 per cent. below said requirements, the particular bar from which it was taken may be rejected, but such tests shall be included in making the average. If any test-piece has a manifest flaw, its test shall not be considered. For each bar thus giving results more than 4 per cent. below the requirements, tests from two additional bars shall be furnished by the contractor without charge, and if in a total of not more than ten tests two bars (or, for a larger number of tests a proportionately greater number of bars) show results more than 4 per cent. below the requirements, it shall be cause for rejecting the lot from which the sample bars were taken. Such lot shall not exceed 20 tons in weight, and bars of single pattern, plates rolled in universal mill or in grooves, and sheared plates, shall each constitute a separate lot. The inspection and tests of the material will be made promptly on its being rolled, and the quality determined before it leaves the rolling-mill. All necessary facilities for this purpose shall be afforded by the manufacturer. A variation in cross-section or weight of rolled material of more than 2 1-2 per cent. from that specified may be cause for rejection.

Specifications for Steel.

No specific process or provision of manufacture will be demanded, provided the material fulfils the requirements of this specification. No steel shall contain more than .08 per cent. of phosphorus. From three separate ingots of each cast a round sample bar, not less than 3-4 in. in diameter, and having a length not less than twelve diameters between jaws of testing machine, shall be furnished, and tested by the manufacturer without charge. These bars are to be truly round, and shall be finished at a uniform heat, and arranged to cool uniformly, and from these test-pieces alone the quality of the material in the steel works shall be determined as follows:

All the test-bars must have a tensile strength from 60,000 to 68,000 lbs. per sq. in., an elastic limit of not less than half the tensile strength of the test-bar, an elongation of not less than 24 per cent., and a reduction of area of not less than 40 per cent. at the point of fracture. In determining the ductility, the elongation shall be measured after breaking on an original length of ten times the shortest dimension of the test-piece, in which length must occur the curve of reduction from stretch on both sides of the point of fracture. Finished bars must be free from injurious flaws or cracks, and must have a workmanlike finish, and round or square test-pieces cut therefrom when pulled asunder shall have reduction of area at the point of fracture as above specified. All the specimens required to satisfy the inspector that the quality of material is satisfactory must be furnished free of charge.

Except for tensile strength, the respective requirements stated are for an average of the tests for each, and are as stated above for wrought-iron in regard to acceptance or rejection.

Rivet steel shall have a tensile strength of from 52,000 to 58,000 lbs. per sq. in., and an elastic limit, elongation, and reduction of area at the point of fracture as stated above for test-bars, and be capable of bending double, flat, without sign of fracture on the convex surface of the bend. The shearing strain per sq. in. on steel rivets and pins shall not exceed 10,000 lbs., and the pressure on the projected semi-intrados of the rivet and the pin-holes 20,000 lbs. per sq. in. Extreme fiber strain for pins must not exceed 25,000 lbs. per sq. in. For field rivets, 25 per cent. in excess of the above requirements will be made.

The inspection and tests for the material will be made promptly on its being rolled and the quality determined before it leaves the rolling mill. All necessary facilities for this purpose shall be afforded by the manufacturer. A variation in cross-section or weight of rolled material of more than 2 1-2 per cent. from that specified may be cause for rejection.

Specifications for Cast-Iron.

Except where chilled iron is specified, all castings shall be of tough gray iron, free from injurious cold shuts or blow-holes, true to pattern, and of a workmanlike finish. Sample pieces 1 in. square, cast from the same heat of metal in sand molds, shall be capable of sustaining on a clear span of 4 ft. 6 ins. a central load of 500 lbs. when tested in the rough bar.

Specifications for Workmanship.

All workmanship must be first-class. All abutting surfaces of compression members, except flanges of plate girders where the joints are fully spliced, must be planed or turned to even bearings, so that they shall be in such contact throughout as may be obtained by such means. All finished surfaces must be protected by white lead and tallow. The rivet-holes for splice plates of abutting members shall be so accurately spaced that when the members are brought into position the holes shall be truly opposite before the rivets are driven. When members are connected by bolts which transmit shearing strains, the holes must be reamed parallel, and the bolts turned to a driving fit. Rollers must be finished perfectly round, and the roller-beds planed. Rivets must completely fill the holes, have full heads concentric with the rivet, of a height not less than 0.6 the diameter of the rivet, and in full contact with the surface, or to be countersunk when so required, and machine-driven wherever practicable. Built members must, when finished, be true and free from twists, kinks, buckles, or open joints between the component pieces.

All pin-holes must be accurately bored at right angles to the axis of the members, unless otherwise shown in the drawings, and in pieces not adjustable no variation will be allowed in the length between centers of pin-holes; the diameter of the pin-holes shall not exceed that of the pins by more than 1-32 in. Eye-bars must be straight before boring; the holes must be in the center of the heads and on the center line of the bars. Whenever links are to be packed more than 1-8 in., to the foot of their length, out of parallel with the axis of the structure, they must be bent with a gentle curve until the head stands at right angles to the pin in their intended position before being bored. All links belonging to the same panel, when placed in a pile, must allow the pin at each end to pass through, at the same time, without forcing. No welds will be allowed in the body of the bar of eye-bars, laterals, or counters, except to form the loops of laterals, counters, and sway-rods; eyes of laterals, stirrups, sway-rods, and counters must be bored; pins and lateral bolts must be finished perfectly round and straight, and the party contracting to erect the work must provide pilot nuts, where necessary to preserve the threads while the pins are being driven. Thimbles or washers must be used whenever required to fill the vacant spaces on pins or bolts. All loop-welded members must be of iron; no weld will be allowed in steel. Swivels or turn-buckles must be open, so as to show the length of bar inside of it.

The Consulting Engineer of the World's Columbian Exposition, or his authorized assistant, may select one full-sized test-bar for each size of bars used, if so deemed necessary. To determine the strength of the eyes, full-size eye-bars, or rods with eyes, may be tested to destruction, provided notice is given in advance of the number and size required for this purpose, so that the material can be rolled at the same time as that required for the structure; and any lot of iron bars from which full-size samples are tested shall be accepted: First, if not more than one-third the bars tested break in the eye; or, Second, if more than one-third do break in the eye, and the average of the tests of those which so break shows a tensile strength in lbs. per sq. in. of original bar, given by the formula:

$$52{,}000 - \frac{7{,}000 \times \text{area of original bar}}{\text{circumference of original bar}} - \begin{cases} 500 \times \text{width of} \\ \text{bar (all in} \\ \text{inches);} \end{cases}$$

and not more than one-half of those which break in the eye fall at more than 5 per cent. below the strength given by the formula. Any lot of steel bars from which full-size samples are tested shall be accepted if the average of the tests shows a strength per sq. in. of original bar, in those which break in the eye, within 4,000 lbs. of that specified above for steel test bars; but if half the full-size samples break in the eye, it shall be cause for rejecting the lot from which the sample bars were taken. All full-size sample bars which break at less than the strength here specified, shall be at the expense of the contractor, unless, if the break occurs in the eye, he shall have made objection in writing to the form or dimension of the heads before making the eye-bars. All others shall be at the expense of the purchaser. If the contractor desires additional tests, they shall be made at his own expense, under the supervision of the purchaser, the acceptance of the bars to be determined by the result of all the tests in the manner above set forth. A variation from the specified dimensions of the heads will be allowed, in thickness of 1-32 in. below and 1-16 in. above that specified, and in diameter of 1-8 in. in either direction.

In iron work, the diameter of the punch shall not exceed by more than 1-16 in. the diameter of the rivets to be used. Rivet-holes must be accurately spaced; the use of drift-pins will be allowed only for bringing together the several parts forming a member, and they must not be driven with such force as to distort the metal about the holes; if the hole must be enlarged to admit the rivet, it must be reamed. Rivets must not be spaced over 6 ins. apart, unless shown otherwise on plans; nor nearer than three diameters of the rivet; nor nearer the edge of any piece than 1 1-4 ins., unless

the same shall be less than 2 1-2 ins. wide. The shearing strain per sq. in. on rivets shall not exceed 8,000 lbs. for iron rivets, and 10,000 lbs. for steel rivets. The bearing pressure shall not exceed 15,000 lbs. for iron, and 20,000 lbs. for steel rivets. Strains on steel pins shall not exceed for bearing 20,000 lbs. per sq. in., for bending strain on extreme fiber 25,000 lbs. per sq. in.

Pin holes in castings must be bored to a diameter not exceeding 1-32 in. larger than the pin. Abutting joints in compression members must be planed smooth, so that the surfaces will be in exact contact throughout; or else to be fully spliced with sufficient materials and rivets to transmit the strains. In all cases where a steel piece in which the full strength is required has been partially heated, the whole piece must be subsequently annealed. All bends in steel must be made cold, or if the degree of curvature is so great as to require heating, the whole piece must be subsequently annealed.

All material before leaving the shops must be scraped free from rust and cinder, and all surfaces painted one good coat of brown mineral paint of satisfactory quality, mixed with pure boiled linseed oil. Surfaces not accessible after assembling must receive two coats of such paint before assembling. Turned pins and planed surfaces to receive a coat of white lead mixed with tallow. If roofs are covered with metal the same shall be painted one good coat of mineral paint before being laid.

Specifications for Timber.

Timber shall be strictly first-class white pine or southern yellow pine. No sap angles will be allowed in sizes under 12 ins., but in sizes above 12 ins. small sap angles, not more than one inch will be permitted. All timber to be sound in every respect, free from large or unsound knots, wind shakes, rot, or any other defect impairing its strength. Timber for rafters, braces, purlins, jack-rafters and ventilators must be planed on all sides. Roof sheathing to be planed on one side.

Pipe and Pipe Laying.

The contract for wrought iron pipe and appurtenances has been awarded by the Bureau of Construction to the John Davis Co., Chicago, at $3,306.50, the quantities and prices being as follows: 1,700 ft. of 4 in. black standard pipe, $374; 15,000 ft. of 3-in., $2,325; 3,000 ft. of 2-in., $225; 500 crosses, 3x2 1-2, $225; 500 tees, 3x2 1-2, $157.50; total, $3,306.50. The other bidders were the American Tube & Iron Co., Chicago, $3,340; Crane Co., Chicago, $3,382.50; James B. Clow & Co., Chicago, $3,433 (Bessemer steel pipe); National Tube Works Co., $3,859. The contract for 1,310 tons of straight cast iron water pipe and 36 tons of castings has been awarded to the Addyston Pipe & Steel Co., Cincinnati, O., at $20.24 per ton of 2,000 lbs for straight pipe, and $38 per ton of 2,000 lbs. for special castings. The other bidders were as follows: Radford Pipe & Foundry Co., Cincinnati, O., $20.90 and $39.50; Detroit Pipe & Foundry Co., Detroit, Mich., $21 and $40; Rhoades & Ramsey Co., Chicago, Ill., $20.95 and $45; Dennis Long & Co., Louisville, Ky., $22.74 and $49; J. H. Bass, Chicago, Ill., $45 for castings only. The contract for pipe laying has been awarded to T. C. Brooks & Co., at $13.118. Mr. William G. MacHarg is the Engineer of Water Supply and Sewerage.

Sewerage.

The contract for sewers and appurtenances to drain the roadways and sidewalks of the exposition grounds has been awarded to Thomas Byrne, at $58,733. The work will include about 64,000 ft. of brick and pipe sewers from 6 ins. to 3 ft. 6 ins. diameter, with manholes and catch basins. The Shone Hydro-Pneumatic Sewerage & Water Supply Co., of Chicago, has had its hydro-pneumatic system adopted for the collection and delivery to one point of the entire sewage of the exposition, and is erecting a plant capable of dealing with 10,000 gallons of sewage per minute. Mr. U. H. Broughton is the company's engineer. The sewage is to be delivered into large iron tanks, where it is to be treated chemically, but this process will be under the charge of Mr. W. G. MacHarg, the Engineer of Water Supply and Sewerage, and not under that of the company.

Only one proposal was made for the electric lighting plant for the World's Columbian Exposition, and that was unsatisfactory. Brisk competition was expected. The management will now probably invite bids from European firms.

EFFECT OF HAUL ON COST OF HANDLING FREIGHT.

The comparative cost on 19 American railways of maintenance of track and rolling stock, comparative train and car loads and other interesting data are discussed in a technical report by Mr. Oscar Petri, late technical attaché of the German embassy in this country. The subject of his report is "The Increase in Car and Train Loads and its Influence upon Running Expenses on North American Railways" (Die Steigerung der Wagenladung und Zugbelastung und der Einfluss derselben auf die Betriebskosten der Nordamerikanischen Eisenbahnen).

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Name of Railway.	Length in miles.	Number of cars in a train.			Average load of		Aver. haul. Miles.	Cost per ton mile. Cts.	Percent. of cost for—				Traffic over one mile in ton.
		Tot'l.	Loaded	Empty.	Tr'in. Tons.	Car. Tons.			Maintenance track, buildings, etc. %	Maintenance of rolling st'ck. %	Transportation. %	G'ner'l and other expenses. %	
Pennsylvania	2,351	29.	19.	10.	285	15.	104.5	0.501	22 23	19.67	47.96	10.04	2,302,000
Lake Shore & Mich. So.	1,341	38.4	25.8	12.6	264	10.1	199	0.410	20.82	17.24	54.06	7.88	1,378,000
Pennsylvania Co.	1,397	23.6	17.95	5.65	239	13.3	90	0.520	23.84	21.46	50.19	4.51	1,128,000
Chi., St. Louis & Pitts.	636	23.3	18.	5.3	227	12.6	190	0.490	18.72	24.45	52.12	4.74	1,109,000
Michigan Central	1,537	26.7	19.4	7.3	209	10.8	219	0.490	22.44	15.63	49.83	12.10	987,000
New York Cent. & H. R.	1,421	25.6	18.1	8.5	205	11 3	180	0.560	17.73	19.86	51.30	11.06	1,393,000
Baltimore & Ohio	1,731	22.	14.4	7.6	198	13.7	191.6	0.488	17.61	24.69	48.10	9.60	1,274,000
Union Pacific	1,824	24.	19.	5.	190	10.	268	0.620	16.60	22.20	46.86	14.34	842,000
Chicago & Alton	849	23.5	15.7	7.8	178	11.3	147	0.603	25.	17.61	43.98	13.43	765,000
Louisville & Nashville	2,546	17.8	12.42	4.76	145	11.6	80.8	0.690	18.96	16.41	52.17	12.46	494,000
Chicago, Mil. & St. Paul	5,672	21.2	15.6	5.6	144	9.2	216	0.600	17.31	16.47	37.36	16.65	285,000
Chicago, Burl. & Quincy	4,846	20.9	15.7	5.2	144	9.2	207	0.69	24.60	15.88	47.06	12.46	326,000
Missouri Pacific	3,030	19.2	13.2	6.0	142	10.7	158	0.88	27.70	15.56	30.09	6.65	345,000
Chi. & Northwestern	4,217	18.5	13.9	4.6	135	9.7	177	0.50	21.67	15.58	56.45	6.30	461,000
Northern Pacific	3,317	20.	15.1	4.9	130	8.6	271	0 83	27.35	14 64	48.09	9.32	212,00
Chicago, R. I. & Pacific.	1,528	19.8	14.7	5.1	128	8.7	212	0.644	21.05	16.51	52.52	9.92	610,000
Atch., Topeka & S. F.	3,023	94.	16.	8.	123	7.7	235	0.86	23.14	20.22	42.68	13.93	270,000
Illinois Central	1,593	19.5	14.3	5.2	116	8.1	157	0.6	20.96	15.80	53.22	10.02	398,000
Richmond & Danville	2,387	17.	12 3	4.7	92	7.5	178	1.03	28.88	13.91	47.06	10.13	132,000

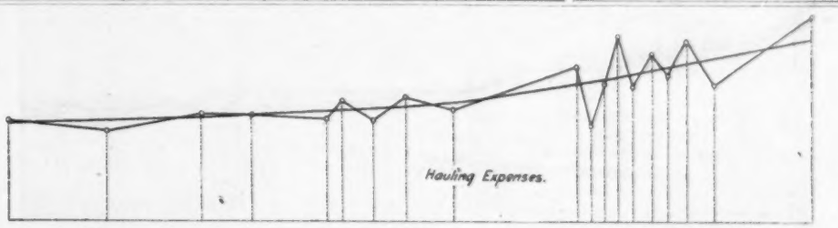


FIG. 1.

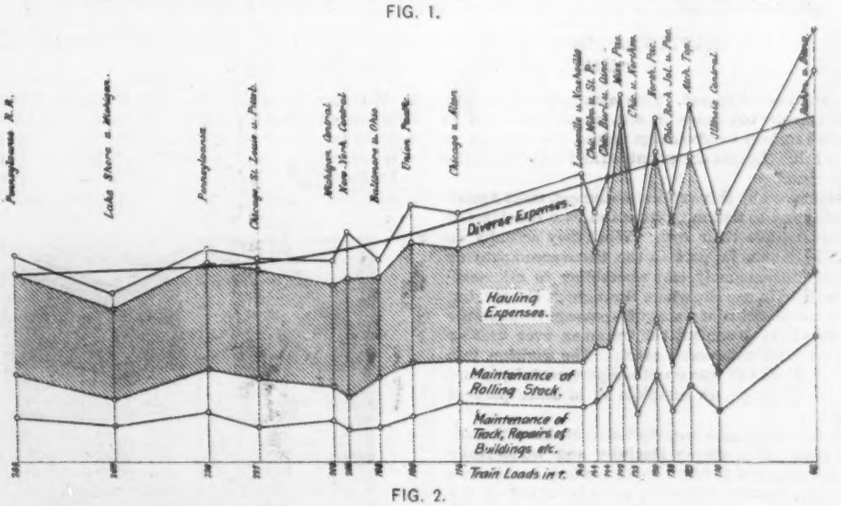


FIG. 2.

The accompanying table gives the main information which he collected. A part of the statistics of the table are used for constructing the accompanying diagrams.

In Fig. 1 the values on the base line represent the train-loads as given in column 6 of the table, while the verticals or ordinates show the several expenses detailed in columns 9 to 13.

Assuming the conditions of traffic, such as price of coal and work, average length of haul, etc., to be equal, the curved line, running as near as possible to all ascertained points, is assumed to demonstrate the relative proportions of train-loads and expense of hauling.

Fig. 2 illustrates the influence of the increased train-load upon the hauling expenses. The shaded or sectioned part of Fig. 1 is constructed in Fig. 2 upon a straight base line. As will be seen, the hauling expenses decrease as the train-loads increase. This is especially noticeable up to the 230-ton mark; from there on upward but a slight difference between the two factors is shown.

The two diagrams are ingenious and well worthy of study.

A novel foundation was used in building a lighthouse at Gull shoal, on Pamlico Sound, North Carolina. The building was to be founded on screw piles and preliminary borings indicated firm material. When work began setting the piles, however, it was found that, although at first penetration was difficult, after 10 ft. depth was reached, there was little resistance to the turning of the screw. The soft layer appeared to extend deeper than the piles were intended to penetrate, and it was not thought prudent to rest the lighthouse on the piles without some additional means of support. It was therefore decided to surround each pile with a cast iron sleeve, 1 3-4 ins. thick and 11 ft. long, provided with a disk of the same material 5 ft. in diameter, intended to bear on the hard upper stratum of the shoal. This scheme had been tested and proved economical and effective at another station in the same lighthouse district. The piles were screwed to a depth of 13 ft., and the sleeves were dropped over them after bolting the disks onto the lower end. The sleeves were secured to the piles by set screws. The lighthouse is a hexagonal wooden building, and is supported on seven piles.

"RAILWAY CARRIAGES ON THE AMERICAN PLAN."

"The railway carriages in German Switzerland," says Baedeker, the traveler's friend and prophet, in his "Handbook for Switzerland," "are constructed on the American plan, generally holding 72 passengers, and furnished at each end with steps of easy access. Through each carriage, and indeed through the whole train, runs a passage, on each side of which the seats are disposed. This arrangement enables the traveler to change his seat at pleasure and to see the scenery to advantage unless the carriage is very full. Tickets are examined and collected in the carriages."

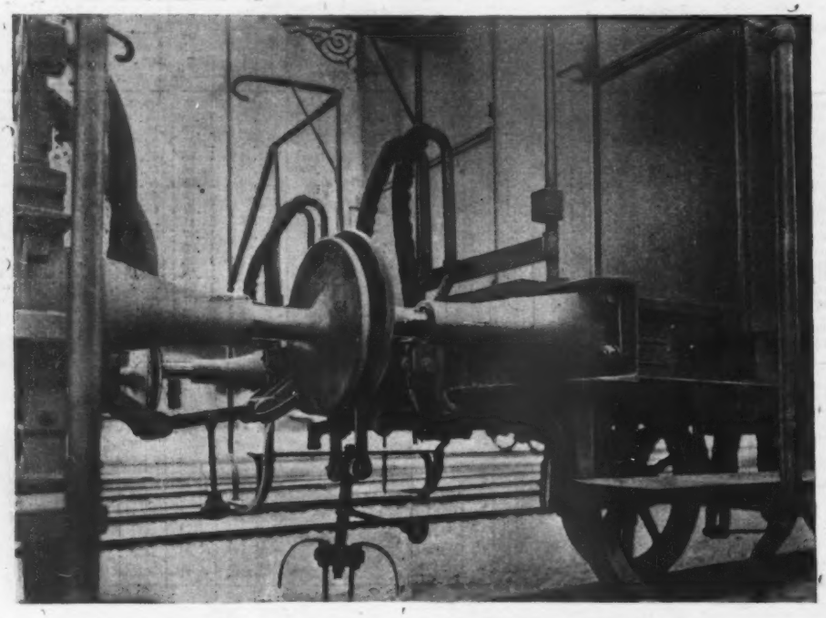


FIG. 1. TRAIN COUPLED UP, SHOWING STEAM CONNECTION STANDARD COUPLING GEAR OF THE "LIMITED EXPRESS," ST. GOTTHARD RAILWAY.

Influenced by this explicit statement, most Americans expect to find in Switzerland cars constructed somewhat like their own. What they actually do find is shown in part in the three accompanying illustrations, namely, cars resembling in all essentials those in use elsewhere throughout Europe, but with the addition of a sort of a passage through the train, which no one but the trainmen ever uses or can use with reasonable safety. The division into three classes and into small compartments is, except for this passage, as complete as in other parts of Europe.

The coupling gear and platforms of these "American plan" cars are so fearfully and wonderfully made that the present writer, when in Lucerne recently, took considerable trouble to obtain the photographs reproduced herewith, to enable their details to be grasped. In order to show the best class of rolling stock, the cars used in the express passenger service across the Alps over the St. Gothard Railway were chosen, but all cars entering the Lucerne station and throughout western Switzerland are substantially the same.

The universal style of buffer is shown in two slightly different forms in Figs. 1 and 3, and the universal style of passenger coupling gear is shown coupled up in Figs. 1 and 3, and uncoupled in Fig. 2. It will be seen to consist of a right and left hand screw, connecting two links, and operated by the weighted arm, which, after screwing up the coupler, is allowed to hang down and thus prevent unscrewing. One of these couplers hangs at each end of each car, and after one of them has been screwed up the other is attached more loosely below it to serve as a check chain.

In all three of the engravings it will be seen that on one of the links there are two big side handles of iron. Possibly they are intended to assist in lifting the coupling. We did know once exactly what these were for, but we find ourselves obliged to confess that we do not know now. "They were doubtless created for some wise purpose, like the measles or New England rum," as Artemus Ward remarks and with that we must leave it.

The same is partially true of the four air brake hose visible in all three of the views. We believe that two of these are for the air brake and two for steam heating, only one of each pair being used at once, but the other being in reserve in case of rupture. Recently, however, a new form of steam hose has been introduced, shown near the bottom of Fig. 1. We may note that throughout Germany and Switzerland steam heating is very common and has been for two or three years. In each compartment of each carriage there is a little lever labeled at each end "Warm" and "Kalt," and thus the temperature of each is very readily controlled by the passengers.

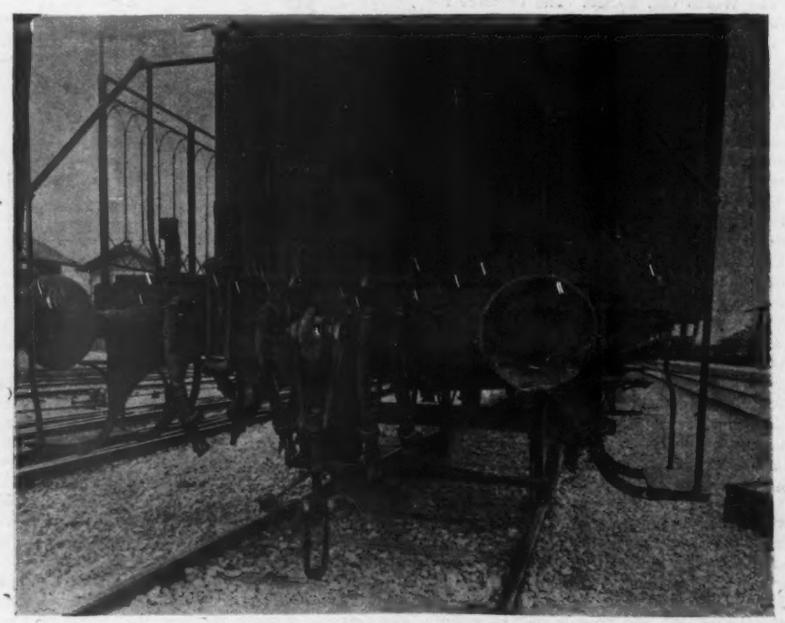


FIG. 2. END VIEW OF REAR CAR.

The gap between the platforms is fully 5 ft., so far as we can recollect and judge from the engravings, and in order to make it possible to step across this gap a hinged plate is used, shown up in Fig. 2 and down in Fig. 1. The edges of the plate are slightly turned up to prevent the foot slipping off sidewise, as shown in Fig. 1. When coupling up this plate is generally lifted.

We presume these plates are amply strong for all requirements, but they yield a good deal under an insistant weight of 230 lbs., and we must confess that we could never acquire a feeling of confidence in them, even for use while the cars were standing still. When in motion no one but the trainmen can safely use them. The lateral and vertical motion between the cars at high speed is very considerable, as it will be obvious that couplings like those shown can exercise but little restraint upon it. The views will also help to explain why there is such an antipathy to sharp curvature in Europe. Coupling gear like that shown is obviously ill adapted to passing over any but very easy curves at passenger speeds.

The car shown in Fig. 2 has side balconies for viewing the scenery, which we need not say is superb. The hand brake is of the screw type, and is rarely used in service. The steps are wholly of iron. Some of the carriages have trucks and some are four wheel, like the second class car in the background of Fig. 1.

Before closing this article we may give "in this connection" a touching appeal of Baedeker's against another "American plan," which immediately follows the paragraph quoted above. He remarks:

> The enormous weight of the large trunks and boxes used by some travelers cause not only great labor, but not unfrequently serious and even lifelong injury to the railway and hotel porters who have to handle them. Heavy articles should be placed in smaller packages, and only the lightest articles in the larger trunks.

As every ounce of baggage that goes in the baggage car has to be paid for at so much a pound, most of the trunks carried on Swiss railways are quite small, and we have never chanced to see any that ought to trouble an able-bodied baggage smasher, still less cause him "lifelong injury," but truth compels us to say that baggage is handled much more carefully abroad than it is here, besides which, many of the baggagemen do not seem to be very robust.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

II.

The entire number of engineering schools properly so-called (i. e., conferring engineering degrees), we stated in our last issue to be 94, and we give below a complete list of these schools, with their post office address and number of graduates in 1889 (or in some cases 1890). They are given for 1889 instead of 1890, because 1889 is the last year covered by the Bureau of Education reports.

Our own statistics run to 1890, however, and we shall supplement them with the number of graduates for 1891 and 1892, as soon as the latter is determined.

Not all of these 94 schools by any means are engineering schools in the proper sense of the term, however. Still fewer of them are of such long standing as to have an established character, and of a somewhat smaller number yet have we accurate information. Those names of colleges which have numbers preceding their names in the subjoined list are the ones from which we have tolerably full information, and which have been established for a sufficiently long time to make the information in regard to them worth detailed tabulation. Those which have reference letters in parentheses preceding their name are classified below as, for one reason or another, not available for the purposes of this inquiry.

The following 11 colleges (marked (a) on list) report that they have no course which can properly be called an engineering course, although most, if not all of them, are working toward one, and are now giving more or less instruction in that direction:

South Carolina, University of. Engineering courses taken away and given to a new agricultural college at Pendleton, S. C.
Georgia, Gainesville College.
Mississippi, Agricultural and Mechanical College.
Texas, Austin College.
Kentucky, State College of, (changes and reorganization pending.)
Indiana, Wabash College.
Kansas, Campbell University.
Kansas, Ottawa University.
North Dakota, University of.
South Dakota, Agricultural College of.
Utah, Agricultural College of.

The following 13 colleges (marked (b) on list) are of such recent establishment that, although they now have regular courses in engineering, which have been in operation for a year or more, the courses are so newly established that it would neither be fair nor profitable to attempt to include them in this investigation, though most of them have favored us with the necessary reports for doing so:

New Hampshire, College of Agricultural and Mechanical Arts.
Pennsylvania, Western University of.
Delaware College.
West Virginia, University of.
North Carolina, Trinity College.
No. Car., College of Agriculture and Mechanical Arts.
Tennessee, University of the South.
Ohio, Case School of Applied Science (a).

(a) Case School of Applied Science.—"A few facts will show you, I think, that you do not want any statistics from us. Our history is too short to be interesting. In fact, our institution is not grown up. It is only a baby, although a lusty one.

"Mr. Case gave the school an endowment of about $2,000,000 worth of real estate in the city of Cleveland. The school was begun in a small way in the Case homestead, in 1881, and was transferred to the new building opposite Wade Park, in 1885. In 1886 the building and all of the school appliances were destroyed by fire, and there was very little insurance. In fact, we had to begin all over again, and we cannot touch the endowment for anything not even for building. All our outlay must come from income. We have replaced the building, and shall build two new ones this spring—a chemical laboratory and a mechanical laboratory; but as you see, we are just filling out. Our four years' course leads to the degree of B. S., and the engineering degrees are post-graduate."

(b) Virginia Military Institute.—"The organization of this institution differs so radically from that of the institutions evidently in the mind of the person who prepared the printed forms sent me, that I think you will arrive at a more satisfactory understanding of the aim and scope of the work of this institution, if, using the form sent by you as a guide, I reply to your questions without attempting to fill out the form, or to reply in minute detail.

"The Institution is known as the Virginia Military Institute, is located at Lexington, Va., was founded in 1839, and is supported and maintained by the state of Virginia. It is a state scientific, military and technical college, and sustains the same relation to the state of Virginia, as that of the Military Academy at West Point to the United States. It was modeled after the U. S. M. A., its founder, and (for 50 years) its superintendent, was a graduate of West Point. This school is strictly 'sui generis.' There is none other like it in the country. Its government is military. Under the laws of Virginia the corps of cadets constitutes an armed guard of the post, and all the officers are commissioned officers in the Virginia militia. For the maintenance of the school the state appropriates $30,000 per annum. The condition of this annuity is, that 50 young men, citizens of Virginia, shall be maintained free of charge for board and tuition. Other students are admitted who pay all their expenses, as do students of other colleges. Besides the annuity from the state, there is an interest bearing fund of $20,000, which yields $1,200 per annum, and this year tuition fees will amount to about $10,000. The total number of matriculates from 1839 to date, is 4,096; of these, 1,417 have received the degree of "graduate" authorized by law. Until 1887 there was a prescribed curriculum, which all students were required to pursue; no options; no elective studies. From 1887 to 1890, at the completion of the third year, cadets of the first or senior class were permitted to elect between the course of general and applied chemistry, and the course of civil engineering. In 1890, the course was so changed that the election between the two above mentioned courses takes place at the end of the second year.

"Up to 1887, all the graduates, numbering 1,334, may be regarded as graduates in the school of engineering, for engineering was a special feature of the curriculum. Since 1887 there has been 48 graduates in engineering. Upon 6 of these 48, who had attained a high degree of proficiency, the degree C. E., authorized for the first time in 1887, has been conferred; the other graduates, having merely received the degree of 'graduate.' I am not able to give the number of graduates now engaged in engineering practice, etc. A large number of our graduates have attained great eminence in the profession. A very large proportion have followed their profession, and their ability, skill and attainments are generally recognized throughout the South. During the war this school supplied the confederate armies with trained and educated soldiers, and it has always been regarded and spoken of as the West Point of the South. In the American supplement to the Encyclopedia Britannica, in the article on 'Military Schools,' Gen. O. O. Howard bears testimony to the worth of this school. The whole academic staff may be regarded as engaged in work in the engineering course. We have complete chemical and mineralogical laboratories, and particular attention is given to laboratory instructions; the classes working systematically in their laboratories, from four to sixteen hours a week, for two years of 40 weeks. We have a physical laboratory to which constant additions of electrical instruments are being made. We have no workshops; no testing machines; teach no mechanical engineering. We have a full supply of field instruments."

(c) In the case of the Missouri School of Mines, the fault is largely our own that we have not more complete returns. The following extracts from a letter in regard to that flourishing institution will be of interest:

"This school was founded through local and political contention in 1871, based on the agricultural land grant of 1862. And since all the land granted lay in south Missouri, the people of the southern part of the state would not consent to all of the funds being expended at Columbia, the seat of the state university. Consequently, as a compromise, the university authorities threw a sop to Cerberus, and established the M. S. S. of M., not thinking it would ever amount to anything.

"But contrary to all expectations, the school, which set out from the beginning as an engineering college, prospered more than it was ever expected it would, and more than was very earnestly desired by the university authorities at Columbia. The result has been a strained feeling between the two institutions.

"Three years and a half ago, when I was put in charge, I threw every energy of the school in the direction of developing to the highest possible degree (with the funds at hand) the engineering feature, and eliminating as far as possible every other. The consequence was that a most surprising strength was developed." The writer then describes an unfortunate rivalry which developed between the State University and the School of Mines, making the position of the latter rather uncertain. The letter concludes as follows:

"The matter has been forced to an issue, and the Board of Curators, now sitting in Columbia, will be forced this week to put themselves on record in no uncertain terms defining our status with respect to the state university, and should they still hold to their previous action, we shall have to have recourse to the next state legislature, and pray that body to separate us from the university altogether."

FIG. 3. VIEW OF COUPLING GEAR, PARTLY DISCONNECTED.

New Mexico, Agricultural College of.
Montana School of Mines.
California, Pierce Christian College.
South Dakota, Pierre University.
Oregon State Agricultural College.

The following 3 colleges (marked (c) on list), while all of them have more or less complete engineering courses which have been established for some time, report that their engineering courses and departments are so intermixed with their other courses that it is impracticable to give separate statistics for them:

Rhode Island, Brown University.
Virginia Military Institute (b).
Tennessee, University of.

To this list might properly be added the U. S. Military Academy at West Point, N. Y., but we do not include this school among the civil engineering schools for obvious reasons. We shall give a separate sketch of its important contributions to the profession of civil engineering.

The following five colleges (marked (d) on list) wrote promising to send reports, no doubt with the best intentions, and in some cases did send partial information, which will be found incorporated in its proper place, but for some reason the promised reports failed to materialize, after as many applications as it seemed becoming to make:

Vermont, University of.
New York, University of City of.
Missouri, School of Mines (c).
Ohio, University of Cincinnati.
California, University of.

While the omission of these five institutions is to be regretted, it is fortunate that no one of them stands very high in the list in respect to number of yearly graduates, which is still more nearly true as respects the other institutions already mentioned.

From the following fifteen colleges (marked (e) on list) we have received catalogues and (in some instances) some further correspondence, but no further information:

New York, Syracuse University.
New Jersey, College of New Jersey (Princeton).
Pennsylvania, Haverford College.
Pennsylvania Military Academy.
Dist. Col., Columbian University.
Maryland, St. John's College.
Virginia, Agricultural and Mechanical College.
North Carolina, University of.
Florida, State Agricultural College.
Alabama, University of.
Tennessee, Vanderbilt University.
Ohio State University.
Missouri State University.
Colorado-State Agricultural College.
Nevada State University.

From the following four colleges (marked (f) on list) we have not received either catalogues or other information, and all our knowledge in regard to them is derived from the reports of the Commissioner of Education:

	Grads. in 1889.
Mass., Agricultural College	14
Md., Agricultural College	4
Miss., Alcorn Agric. and Mech. College	9
Ky., Agricultural and Mech. College	4

The preceding lists of colleges from which we have no detailed information (marked (a) to (e) on list), report either that they have no separate en-

gineering course, properly so-called, or that their courses are just established, while 24, marked (d), (e), (f), send little or no information; but we know in other ways that, if reported, the engineering courses of all but five or six of them, are too recently organized or imperfect to justify detailed analysis.

We may say with substantial truth, therefore, that the lack of detailed reports from all these 51 institutions last enumerated is easily explained by the fact that they have nothing to report pertinent to the scope of this inquiry. Even the two institutions whose absence from the list is most to be regretted, Princeton and the College of the City of New York, are among the minor schools of engineering compared with most of the 43 colleges of some considerable age and standing from which we have tolerably complete reports.

The institutions in the first column of the following summary are (with two or three partial exceptions) the only ones which have now any important standing as fully developed and active engineering schools.

Summary of the Engineering Schools named in the Subjoined List.

	Reported in some detail.	Not reported in detail because of—			Total eng. schools proper.		
		(b)	(c)	(d)	(e)	(a)	(f)
New England	7	1	1	1	..	10	..	1
Middle	13	2	..	1	4	20	..	..
Southern	7	4	2	..	7	20	5	3
No. Central	16	3	..	2	3	24	5	..
Pacific	0	3	..	1	1	5	1	..
Total	43	13	3	5	15	79	11	4

(a) Not strictly an engineering school.
(b) Too recently established.
(c) Engineering courses not separate from others.
(d) Sent imperfect information.
(e) Sent catalogues only.
(f) Sent no information.

The following summary of the number of graduates in 1889 (the last year for which we could give them all) from the schools in each of these columns will also be of interest. It will not quite check with the returns from the listed schools (first column) for the same year, which we shall give later, because taken from the Bureau of Education reports, to compare properly with the other columns.

Total Number of Graduates, 1889.

(As reported to the Bureau of Education, with some corrections.)

	In listed Schools.	In schools marked. (a)	(b)	(c)	(d)	(e)	(f)	Total
New England	138	..	6	.	3	..	14	161
Middle	216	..	2	..	13	24	..	255
Southern	20	28	8	5	..	22	17	100
No. Central	115	6	6	..	22	35	..	184
Pacific	..	..	13	..	11	..	..	24
Totals	489	34	35	5	49	81	31	724

The first column only, in our judgment, includes about as many graduates (489) as can be considered to have received degrees in engineering, properly so-called, there being a few in this column who were hardly graduates from engineering courses, and a few inside of it who were. The remaining 235 graduates were graduates in science, but not strictly in engineering.

COMPLETE LIST OF THE ENGINEERING SCHOOLS OF THE UNITED STATES CLAIMING STANDING AS SUCH; WITH NUMBER OF GRADUATES IN 1889-90.

Names having numbers prefixed are schools of recognized standing and some age, of which we have more or less complete reports.
Names having (a) prefixed are not strictly engineering schools, though working in that direction.
Names having (b) prefixed are too recently established to have their character determined.
Names having (c) prefixed have no separate and distinct engineering courses.
Names having (d) prefixed furnished scant information.
Names having (e) prefixed sent catalogues only.
Names having (f) prefixed sent no information.

	Name of College.	Location.	No. grads. '89.
20	Maine Agricultural College	Orono,	6
(b)	New Hampshire Agricultural College	Hanover,	6
23	1-2 Dartmouth (Sci. Dept.)	Hanover,	2
3	Mass., Harvard Univ. (Sci. Dept.)	Cambridge,	0
10	Mass. Institute of Technology	Boston,	60
13	Tufts College (Sci. Dept. of)	College Hill,	4
18	Worcester Polytechnic School	Worcester,	27
(f)	Mass. Agricultural College	Worcester,	14
(d)	Vermont, Univ. of, (Sci. Dept.)	Burlington,	3
(c)	Rhode Island, Brown University	Providence,	0
2	Conn., Yale Univ. (Sci. Dept.)	New Haven,	39
	Total, New England States, 11 schools		161
1	N. Y., Rensselaer Polytechnic Inst.	Troy,	18
4	N. Y., Union Col., (Sci. Dept.)	Schenectady,	4
6	N. Y., Brooklyn Polytechnic Int.	Brooklyn,	7
8	N. Y., Columbia Col. (Sci. Dept.)	New York,	29
12	N. Y., Cornell Univ. (M. E. Dept.)	Ithaca,	14
24	1-2 N. Y., Cornell Univ. (M. E. Dept.)	Ithaca,	33
(d)	N. Y., Univ. of City of New York (Sci. Dept.)	New York,	13
(e)	N. Y., Syracuse University	Syracuse,	6
22	1-2 N. J., Stevens Institute	Hoboken,	36
27	N. J., Rutgers College (Sci. Dept.)	New Brunswick,	14
(e)	N. J., College of New Jersey	Princeton,	..
7	Penna. Military Academy	Chester,	11
22	Penna., Univ. of Pa. (Sci. Dept.)	Phila.,	9
24	Penna., Swarthmore Col. (Sci. Dept.)	Swarthmore,	6
10	1-2 Penna., Lehigh University (Sc. Dept.)	Bethlehem,	31
15	Penna., Lafayette Col. (Sci. Dept.)	Easton,	4
(b)	Penna., Univ. of Western Pa. (Sci. Dept.)	Allegheny,	1
(e)	Penna., Haverford Col. (Sci. Dept.)	Haverford College,	7
(e)	Penna., Pa. Military Academy	Chester,	11
(b)	Del., Delaware College (Sci. Dept.)	Newark,	1
	Total, Middle States, 20 schools		255
(e)	D. C., Columbian Univ. (Sci. Dept.)	Washington,	0
(f)	Md. Agricultural Col. (M. E. Dept.)	Agricultural College,	4
(e)	Md., St. Johns Col. (Sci. Dept.)	Annapolis,	4
9	Va., Washington and Lee Univ. (Sci. Dept.)	Lexington,	1
11	Va., Univ. of (Sci. Dept.)	Charlotteville,	5
(c)	Va. Military Institute	Lexington,	5
(e)	Va. Agricultural and Mechanical College (M. E. Dept.)	Blacksburg,	3
(b)	W. Va., University of (Sci. Dept.)	Morganstown,	6
(b)	N. C., Trinity Col. (Sci. Dept.)	Trinity Col.	0
(b)	N. C. Col. of Agr. and Mech. Arts (M. E. Dept.)	Mt. Pleasant,	0
(e)	N. C., Univ. of, (Sci. Dept.)	Chapel Hill,	1
(a)	S. C., Univ. of, (Sci. Dept.)	Columbia,	9
14	Georgia, University of, (Sci. Dept.)	Athens,	4
42	Georgia, School of Technology	Atlanta	2
(a)	Georgia, Gainesville College, (Sci. Dept.)	Gainesville,	..
(c)	Florida, Agr. Col., (M. E. Dept.)	Lake City,	2
19	Alabama, Polytechnic Institute	Auburn,	6
(e)	Alabama, Univ. of, (Sci. Dept.)	University,	2
(f)	Miss., Alcorn Agr. and Mech. College		9
(a)	Miss. Agr. College, (M. E. Dept.)	Agr. C.,	19
31	Texas Agr. Col. (M. E. Dept.)	College Sta.	..
37	Texas, University of, (Sci. Dept.)	Austin,	2
(a)	Texas, Austin College, (Sci. Dept.)	Sherman,	..
(b)	Tenn., University of the South, (Sci. Dept.)	Suwanee,	2
(c)	Tenn., University of, (Sci. Dept.)	Knoxville,	..
(e)	Tenn., Vanderbilt University, (Sci. Dept.)	Nashville,	10
(a)	Kentucky, State College of		
(f)	Kentucky Agri. and Mech. College, (M. E. Dept.)	?	4
	Total, Southern States, 28 schools		100
(b)	Ohio, Case School of Applied Science	Cleveland,	6
(d)	Ohio, University of Cincinnati, (Sci. Dept.)	Cincinnati,	7
(e)	Ohio, State Univ., (Sci. Dept.)	Columbus,	15
35	Indiana, Purdue Univ. (Sci. Dept.)	Lafayette,	13
36	Indiana, Rose Poly. Institute	Terre Haute,	8
(a)	Indiana, Wabash College, (Sci. Dept.)	Crawfordsville,	..
30	Illinois, Univ. of, (Sci. Dept.)	Champaign	4
5	Michigan, Univ. of, (Sci. Dept.)	Ann Arbor,	19
39	Michigan Mining School	Houghton,	6
40	Michigan Agri. Col., (M. E. Dept.)	Agri. Col.	6
23	Wisconsin, Univ. of (Sci. Dept.)	Madison,	9
26	Minn., Univ. of (Sci. Dept.)	Minneapolis,	3
28	Iowa, University of (Sci. Dept.)	Iowa City,	2
29	Iowa, Cornell College, (Sci. Dept.)	Mt. Vernon,	8
21	Iowa Agri. College, (M. E. Dept.)	Ames,	7
16	Missouri, Washington University, (Sci. Dept.)	St. Louis,	3
(d)	Missouri School of Mines	Rolla,	15
(e)	Missouri State Univ., (Sci. Dept.)	Columbia,	16
17	Kansas Agri. Col., (M. E. Dept.)	Manhattan,	17
25	Kansas, Univ. of, (Sci. Dept.)	Lawrence,	3
(a)	Kansas, Campbell Univ. (Sci. Dept.)	Holton,	..
(a)	Kansas, Ottawa Univ., (Sci. Dept.)	Ottawa,	..
32	Nebraska, Univ. of, (Sci. Dept.)	Lincoln,	3
(a)	North Dakota, University of, (Sci. Dept.)	Grand Forks,	3
(a)	South Dakota, Agricultural College of, (M. E. Dept.)	Brookings,	3
(b)	South Dakota, Pierre University, (Sci. Dept.)	Pierre,	0
33	Colorado School of Mines	Golden	4
(e)	Colorado State Agr. College (M. E. Dept.)	Ft. Collins,	4
(b)	Montana School of Mines	Deer Lodge,	0
	Total, North Central States, 29 schools		184
(b)	Oregon State Agricultural College, (M. E. Dept.)	Corvallis,	13
(b)	California, Pierce Christian College, (Sci. Dept.)		0
(d)	California, University of, (Sci. Dept.)	Berkeley,	11
(e)	Nevada State Univ., (Sci. Dept.)		0
(b)	New Mexico Agri. Col., (M. E. Dept.)		0
(a)	Utah, Agricultural College		..
	Total, Pacific States, 6 schools		24

The Dominion of Canada has:
McGill College, (Sci. Dept.) Montreal, ..
Toronto University, (Sci. Dept.) Toronto, ..
And others deserving enumeration, in a complete list, but no attempt has been made to gather the statistics of the Canadian engineering schools. The two named are the principal engineering schools of Canada; McGill College especially is very well equipped.

The deep artesian well at Wheeling, W. Va., has been sunk by the Wheeling Development Co. to a depth of 4,462 ft. Observations have been taken, during at least a part of the sinking of the well by U. S. Government experts. The temperature of the well has increased from 68.75 degrees F. at 1,350 to 110.15 degrees F. at 4,462 ft. in depth.

THE INTERNATIONAL RAILWAY CONGRESS.

This association, little known on this side of the water, and having its headquarters in Europe, has for its object to promote the progress of improvement in all matters connected with the construction, equipment and operation of railways. It is composed of the representatives of state and private railways, and delegates from many national governments. The association is represented by a commission, having offices at Brussels, Belgium, and this commission has charge of the arrangements for the meetings, and also of the financial affairs, publications, etc. The meetings of the Congress are held every two years; the governments belonging to the association fix the number of their delegates; while railways not exceeding 62 miles in length send two delegates, those of 310 miles send 3 delegates and beyond that there is 1 delegate for each length of 310 miles or fraction thereof. The official language of the association is French. The annual payments for railway systems belonging to the association are a minimum charge of $20, plus a charge varying with the length of the system. The governments fix for themselves their annual payments. The membership now consists of 31 governments (including those of most of the European countries, the British colonies, and several in South America), and 241 railways, steam tramways, etc., in 45 countries and colonies. The total mileage of railways represented is 120,000 miles. While the Congress covers nearly the whole world, including even Persia, the only railway in the United States which belongs to the association is the Pennsylvania R. R., with a mileage of 3,650 miles. This is to be regretted, as the proceedings and discussions of the Congress are very important and valuable, and American railways are leading in many directions of progress.

A bulletin is issued monthly, containing elaborate papers and discussions upon various subjects connected with railway work, such as the design of locomotive boilers, the heating of passenger cars, the improvements of tracks for high speed traffic, the block system and signals, passenger and freight rates, light railways, etc. This bulletin is issued by the Commission as already noted. M. Belpaire, Director General of the Belgian State Railways, is President, and M. Weissenbruch, Engineer to the Belgian Minister of Railways, is Secretary.

The next meeting will be held at St. Petersburg, Russia, in June, 1892, lasting about two weeks, and the following is a list of the subjects to be considered:

Uniform technical terms.
Frogs and switches.
Maintenance of track.
Limit of wear of tires and rails.
Relation between track and bridges, and track and rolling stock.
Track for fast trains.
Control of speed of trains.
Breakage and wear of steel rails.
Maintenance of track on metal and wooden ties.
Wooden ties; durability and preservative treatment.
Track and rolling stock on curves.
Production of steam in locomotive boilers.
High pressure and the compound system.
High pressure and different valve gears.
Rolling stock for lines with light traffic.
Continuous heating for passenger trains.
Locomotive running, double crew system vs. "first-in-first-out" system.
Locomotives; fuel consumption, tubes, tires, lubrication, crank axles, fireboxes, boilers, switch engines.
Lubrication of car axle journals.
Signals and the block system; lighting of signals.
Intercommunication signals on trains.
Distribution of empty freight cars.
Interchange of rolling stock.
Freight handling by station masters at small stations.
Operation of railways with light traffic.
Use of stations, passenger cars and freight cars.
Railways for new countries.
International relations of railways.
Transfer of cars of different gages of track.
Union stations and lines; distribution of expenses.
Distribution of traffic and common rates for different railways.

Passenger traffic, tickets, zone tariff system, etc.
Freight traffic; capacity of cars, freight rates.
Pensions to employees.
Railway administration of hotels, restaurants, etc.
Cost of operation.
Light railways; gage, locomotives, rolling stock, electric and other traction, administration, legislation, their use as feeders to main lines.

STANDARD TYPES OF PLATE GIRDER BRIDGES, SWISS NORTHEASTERN RAILWAY.

The main and distinguishing feature of these new types of plate girders, for illustrations and descriptions of which we are indebted to the "Schweizerische Bauzeitung," is the continuous bed of ballast carried without interruption from bank to bank. This mode of construction is found to make the structures 10% to 15% heavier and more expensive, but on the other hand, their vibrations are reduced almost to a minimum. To serve as a support or floor for the ballasting, troughs made of mild steel are used, and are either laid longitudinally or transversely, according to the height available for construction. The least height is occupied by the bridge with ballast let in between the girders (Fig. 1). The troughs are placed longitudinally and rest on flat straps of iron, $\frac{3}{8}$ in. high and about 2 ins. wide, fastened to the tops of floor-beams by countersunk rivets. These straps serve to protect the angles of floor-beams from being bent downward by strains on the troughs, and also to transmit the live loads to the floor-beams axially. On both sides of the track sheets of iron are placed, resting against the gusset-plates connecting floor-beams with the main girders. The box thus formed receives the ballasting to the height of 12 ins. above the top of the troughs. Ties are laid in the customary way, and can be tamped in the same manner as on the solid ground. Under the rails the troughs are laid closer than in the center. The ballast rests upon a solid layer of concrete, which covers the troughs entirely.

Connected with the ballasting of the track are the foot walks at both sides of the former. The light weight troughs for these rest on brackets and are also laid in concrete. In spans of 20 ft. or less the tops of plate girders are covered by the ballast, as in Fig. 1, and are protected from the ballast by a cover plate as shown. If a greater height of girder is necessitated by a larger span, the top of the girder extends above and separates the ballasting of the track and footwalk.

As it is known that concrete will absorb more or less moisture from the atmosphere, a sheet of "Holz cement" (a material similar to our tarred felt, we presume) is used to cover the layer of concrete and give it a waterproof surface. A grade or fall of 3% is deemed necessary to carry the water filtering through the ballast to the gutters on each side. At the abutments, or, if necessary, at intermediate places drains are let into the concrete, and the seams between this and the "Holz cement" calked in the usual manner. The footwalks have a similar waterproof covering. In smaller spans the water from these collects in the main gutters, while in larger ones separate drains or gutters serve that purpose.

The troughs of the track extend out upon the abutments, so that the ballasting is carried along without interruption, while the ballasting of the footwalks is separated from the edge of the masonry by an angle iron.

A very strong and heavy cross section of trough is used, the width of foot being 12 ins.; height, 5 ins.; weight per yard, 62.5 lbs.; material, mild steel.

In bridges which permit of greater height, as as shown in Fig. 2, the troughs are laid transversely. Their bearing is practically the same as already described. The lateral bracing for this kind of bridge consists of a frame of double angle irons supporting the footwalk. The ballasting, drainage, etc., are much the same as in Fig. 1, as described above.

The other details of construction of these types of plate-girder bridges can be understood from the accompanying engravings. The arrangement of shoes at the ends may as well be mentioned, however, and is shown in Fig. 3. The plates, $\frac{13}{32}$ to $1\frac{1}{4}$ in. thick, riveted to the cover plates at the bottom of girders on one end, contain grooves to receive two projections on top of the shoe. Thus a fixed bearing is formed on one end, while the other end is permitted to slide upon its bearing.

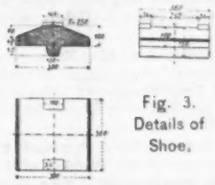


Fig. 3. Details of Shoe.

An electric railway is to be built at Madras, India, by the Madras Electric Tramway Co. The lines will aggregate 15 1-2 miles in length, or 18 1-2 miles of track including passing places and side tracks. They will be of meter gage, and the current will be taken from overhead wires. The company has a capital stock of $500,000, and has power to contract for the electric lighting of streets and buildings.

A new storage battery street car has been brought out at Cleveland, O., by the Ford-Washburn Storelectro Co. The battery material is not in the form of plates, which have given trouble by warping and breaking loose from their connections, but in the form of rectangular cups. A 150 ampere-hour cell is 12x 4 1-2x8 ins., and weighs 40 lbs. The batteries are hermetically sealed, and annoyance from acid fumes is claimed to be reduced to a minimum. A car 28 ft. long over all and 21 ft. inside the body has been equipped with 7,200 lbs. of batteries, and has been run experimentally over various parts of the Cleveland street railways, drawing trail cars up grades and around curves, and is stated to have given excellent satisfaction. The batteries are so placed in the car that they can be changed for a fresh set in three minutes. The car has a 35 HP. motor weighing about 2,000 lbs., with the armature lengthwise of the car. Connection is made to the axles through an intermediate shaft and bevel gearing.

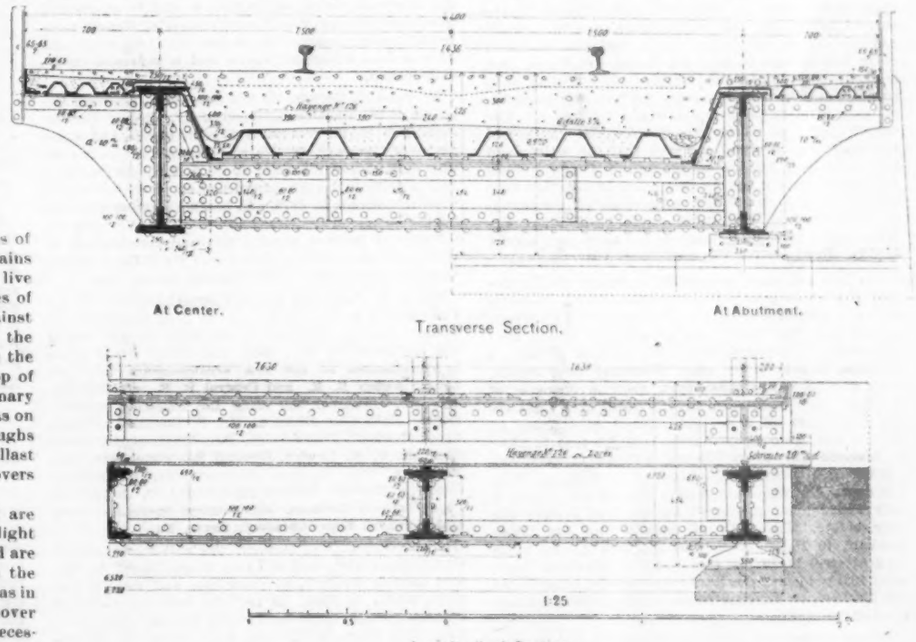


FIG. 1. PLATE GIRDER BRIDGE WITH LONGITUDINAL TROUGH FLOOR.

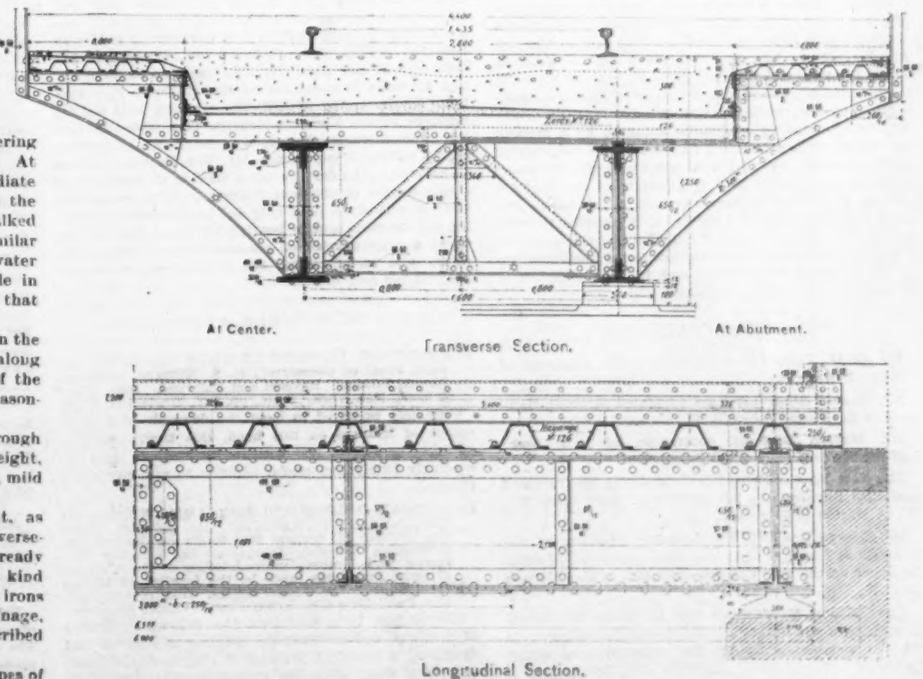


FIG. 2. PLATE GIRDER BRIDGE WITH TRANSVERSE TROUGH FLOOR.

A screw steamer, the "Hartford," is being built for the New York & New Haven Line. She will be 240 ft. long, 40 ft. beam, and have accommodations for 200 passengers.

The Chicago Drainage Board has had submitted to it a form of contract and specifications for the work to be done on the main drainage channel, between Willow Springs and Lockport, as prepared by Chief Engineer Williams and Attorney Carter. By this form the contractor is to furnish all the work and materials, leaves the engineer to absolutely settle all points not covered in the specifications, must not sublet under penalty of forfeiture of contract, and must employ only American labor. Ordinances were adopted, locating the 16 miles of route between the points mentioned. The specifications place the elevation of the channel at Willow Springs at 23 ft. below Chicago datum, and 30 ft. below at Lockport.

Special facility compensation for railways is condemned by Postmaster General Wanamaker, in a letter addressed to the Chairman of the House Committee on Post Offices and Post Roads. This system of compensating certain railways for carrying the U. S. mails commenced in 1879, and cost $196,614 in the current fiscal year. Mr. Wanamaker says this special payment to certain roads, to the exclusion of others doing like service, is annoying to the department, and is really prejudicial to the service. The railway companies are paid ordinary rates for the transportation of mail, in addition to the subsidies referred to. The quantity of mail matter has doubled since 1879, and the conditions of travel are such that the mails could be transported quicker on several of the long lines subsidized, were it not for the subsidies affecting time schedules. In fact, one day could be gained, he shows, in the delivery of West Indian mails, via Florida. Mr. Wanamaker does not recommend the customary special facility allowance for the next fiscal year.

The iron and steel production in Great Britain for 1891 fell off in raw materials and finished products, says the preliminary report of the British Iron Trade Association. The production of pig iron was 7,228,496 tons, as compared with 7,875,130 tons in 1890, a decrease of over 8 per cent. Bessemer steel ingots, with a total of 1,642,005 tons, show a decrease of 18.5 per cent., while open hearth steel, with 1,514,538 tons, only fell off 3 per cent. Steel rails figure at 662,676 tons, as compared with 1,019,606 tons in 1890. As America takes fewer billets and blooms now, the output for 1891 was only 213,443 tons, a decrease of 31 per cent. For the same reason the tin-bar output is only 18,326 tons, one-fourth as much as it was the year before. The make of metallic ties has fallen one-half, to 18,825 tons. The decrease in the make of acid steel is 19 per cent., and in Bessemer basic steel 16.5 per cent., the total output of the latter being 335,776 tons, or one-fifth of the total of the Bessemer steel output.

An electric railway to the summit of Mt. Wilson from Pasadena, Cal., is in a fair way to be built during the coming season according to the Los Angeles, Cal., "Times." Mount Wilson is one of the prominent peaks of the portion of the Coast Range known as the Sierra Madre, which forms the northern boundary of the Los Angeles valley. The line will start from a point in Rubio Canyon, and the first 2,000 ft. will be a double track inclined plane operated by cables on the counterbalance system, having a rise of 1,600 ft. The cables will be operated by a dynamo actuated by a turbine run by the stream in Rubio Canyon. From the summit of the incline the road will run along the mountain ridge about 12 miles to a terminus near the Harvard College astronomical observatory on Mt. Wilson. The total rise will be about 4,500 ft. It is intended to build a large hotel at the top of the incline and the object of the line is principally to accommodate the tourist travel. T. S. C. Lowe is President and D. J. McPherson is Chief Engineer, both of Pasadena, Cal.

PERSONALS.

Mr. O. H. Tripp has been elected City Engineer of Rockland, Me.

Mr. Donald Allen has been appointed General Manager of the Pecos Valley R. R.

Mr. Warren Rosevelt, contractor, of New York, has removed his office to 16 Beaver St.

The New York & Rosendale Cement Co. has removed from 229 Broadway to 280 Broadway, New York. Mr. W. C. Morton is Secretary.

Mr. George Crocker, late Locating Engineer of the Roanoke & Southern Ry., has been appointed Division Engineer on the new Chicago extension of the Wabash Ry.

Hon. William R. Morrison was, on March 19, elected Chairman of the Interstate Commerce Commission, to fill the vacancy made by the resignation of Judge Cooley.

Mr. A. C. Chapin, ex-Mayor of Brooklyn, N. Y., has been appointed a member of the Railroad Commission of New York state, vice Mr. Isaac V. Baker, whose term has expired.

Mr. D. C. Dunlap has resigned as City Engineer of Rockford, Ill., to accept the Presidency of the new Chicago, Lake Geneva & Northwestern Ry. Mr. Dunlap is also interested in the Belt Line Ry., to be constructed around Rockford.

Mr. M. A. Zook has been appointed Principal Assistant Engineer of the Lake Shore Division of the Lake Shore & Michigan Southern Ry., with headquarters at Dunkirk, N. Y., vice Mr. F. E. House, resigned to accept position as Engineer of Maintenance of Way on the Pittsburg & Lake Erie R. R., with headquarters at Pittsburg, Pa.

Messrs. L. E. Cooley and J. M. Howells have formed a partnership for carrying on a general engineering practice, with office at 169 La Salle St., Chicago. Mr. Cooley is one of the best known engineers in the West, and his experience has been wide and general. He has served two terms as President of the Western Society of Engineers, and is at present a member of the Board of Trustees of the Chicago Sanitary Commission. Mr. Howells has been connected with several important works and is well and favorably known.

Mr. John H. Morton, M. Am. Soc. C. E., Locating Engineer of the Rio Grande Western Ry., died at Denver, Colo., Feb. 8. He was about 45 years of age, and was a native of Conneaut, O. He was an assistant on the Oil City extension of the Lake Shore & Michigan Southern Ry. in 1868, and after experience on several roads he went to Colorado in 1878, and became locating engineer for the Denver & Rio Grande R. R. He had a large experience of location, construction and maintenance on various Western railways, and was appointed Locating Engineer of the Rio Grande Western Ry. in 1891.

Mr. I. A. Sweigard, General Superintendent of the Philadelphia & Reading R. R., has been appointed Assistant General Manager of all lines owned, leased and controlled by that road, the change being made in consequence of the new arrangements with the Lehigh Valley R. R. and Central R. R. of New Jersey. Mr. Sweigard has made the following appointments; Main Line Division, Mr. F. Bonzano, General Superintendent, Philadelphia, Pa.; Williamsport Division, Mr. C. M. Lawler, General Superintendent, Williamsport, Pa.; Eastern Division, Mr. H. Stanley Goodwin, General Eastern Superintendent, Bethlehem, Pa.; Northern Division, Mr. William Stevenson, General Northern Superintendent, Sayre, Pa.

Mr. Charles J. Van Depoele, the well-known electrician and inventor, died at Lynn, Mass., March 18. He was born in Belgium, 46 years ago, and went to Detroit, Mich., in 1869. In 1877 he built an electrical laboratory, and there constructed several large dynamos, with which exhibitions were given. In 1878 he lit up Forepaugh's Circus, and also illuminated Recreation Park for the benefit of the baseball enthusiasts. In 1871 he established himself in Chicago. His first experiments in the electric propulsion of street cars were made in 1882, and his first commercial road was equipped in 1885, at South Bend, Ind., where five cars were run at one time. By 1888 the Van Depoele Co. had 13 roads in operation on the overhead wire system. In the spring of 1888 the company sold out its business to the Thomson-Houston Co., whose service Mr. Van Depoele thereupon entered as electrician of the railway department. Mr. Van Depoele claimed to have been the first to run a number of cars from a single source of constant potential, using separately excited generators. Not only did he develop the lighting and traction system bearing his name, but he produced a great number of commutatorless motors, both rotary and reciprocating, the latter being especially adapted for rock drilling.

NEW PUBLICATIONS.

ELEMENTARY LESSONS IN HEAT. By S. E. Tillman, Prof. of Chemistry, U. S. Military Academy. Second Edition. Revised and Enlarged. John Wiley & Sons, New York. 8 vo., pp. 162, illustrated, $1.50.

Originally prepared to meet the demands of a short course of lectures on this head, this treatise clearly outlines the subject and with its illustrations is an exceedingly handy and useful addition to any engineer's library.

PRACTICAL DIRECTIONS FOR ARMATURE AND FIELD-MAGNET WINDING. By Edward Trevert, Author of various text-books on Electricity. Containing Working Directions for Winding Dynamos and Motors, with Additional Descriptions of some Apparatus made by the Leading Electrical Companies in the United States. Illustrated. Baubier Publishing Co., Lynn, Mass. 12mo., pp. 113.

The author fully describes the difficult operation of properly and successfully winding armatures and dynamos, a practical feature of electrical manipulation upon which little has heretofore been published. Mr. Trevert commences with the theory of the armature, and proceeds then to practically describe and plainly illustrate the various form of drum and field winding, dynamos and armatures. It is a practical book, handled from the standpoint of an expert manipulator.

VOCABULAIRE DES HOMONYMES SIMPLES DE LA LANGUE FRANCAISE. Par Chs. Baillairge. A M. Ingenieur de la Cite de Quebec, membre de la Societe Royal du Canada. Joliette, Quebec. 12mo,, pp. 212.

VOCABULARY OF ENGLISH HOMONYMS. By C. P. F. Baillairge, M. A., F. R. S. C., etc. C. Darveau, Quebec. 12mo., pp. 190.

The author of these works, published in English and French, is already well known as the City Engineer of Quebec, and as the writer of one of the most original and plain spoken reports on the operations of his department probably ever sent out by an engineer to his superiors. Mr. Baillairge defines homonyms as words, which, whether spelled alike or differently, have different meanings. He believes that this study has most decided educational advantages, especially in rapidly enlarging the vocabulary of children. He has certainly brought together a curious collection of English words similar in sound, though some might object when he couples the "kilt" of a Highlander with "kilt, killed," for example. But as a rule the words are well selected and as a consequence the book is a useful and curious addition to the history of our language. The French edition covers similar ground and is especially valuable to students of that language.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF VIRGINIA. For the year ending June 30, 1891. Pub. Doc., 8vo., pp. Lxxxii., 646. Index.

This report contains nothing of technical interest and very little else except the large mass of figures contained in the reports of the various companies to the Commissioners, which are so entirely without arrangement as to be useless for any general deductions. It is but fair to say, however, that this result is due rather to the lack of proper compensation and funds for doing the work properly than to the incapacity, or lack of energy, of the Commissioner.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NORTH CAROLINA. For the nine months, April 1 to Dec. 31, 1891. Pub. Doc., 8vo., pp. 668.

This being the first report of the commission, which was organized on April 1, 1891, it covers but nine months of the year, and is necessarily incomplete. It is to be regretted that Dec. 31 was selected for the close of the fiscal year. This should be changed to conform to the fiscal year of the Interstate Commerce Commission and most of the state railroad commissions, which closes on June 30. The first 141 pages consist almost entirely of the text of the laws creating the commission, the standard freight and passenger classifications and tariffs, and tables showing assessments for taxes. The remainder consists of the reports of the various companies. There is no matter of technical interest.

WATER-WORKS REPORTS.—(The receipt of water-works reports will hereafter be acknowledged under this head. Further comments will be made from time to time under "Notes from Recent Water-Works Reports" whenever the reports contain matter calling for special notice. The names given in connection with each are those of superintendents unless otherwise stated.)

The following reports have been received: Burlington, Vt., F. H. Crandall; Fitchburg, Mass., T. C. Lovell, A. W. F. Brown, Registrar; Plymouth, Mass., R. W. Bagnell; Whitman, Mass., J. C. Gilbert; Gloversville, N. Y., J. B. Tuckerman; Bay City, Mich., E. L. Dunbar; Detroit, Mich., L. V. Case, Secy.

CITY REPORTS.—The following reports of City Engineers and other city officials have been received, the reports being those of city engineers and the gentlemen named officiate in that capacity unless otherwise specified: Cambridge, Mass., L. M. Hastings; Haverhill, Mass., John T. Desmond; Newton, Mass., A. F. Noyes; Pawtucket, R. I., Sewer Commissioners, A. R. Sweet, Engineer; Waterbury, Conn., R. A. Carns; Troy, N. Y., Public Improvement Commissioner, P. C. Ricketts, Engineer; Passaic, N. J., City Reports, C. R. Wise; Austin, Tex., City Reports, J. P. McFall, City Engineer; W. J. Oliphant, Secretary Board Public Works.

TRADE PUBLICATIONS.

PLANING MILL EXHAUSTERS.—Buffalo Forge Co., Buffalo, N. Y. Sq. 12mo., pp. 24.

An illustrated catalogue of steel plate planing mill exhausters for wood-working industries, with diagrams of hoods.

SPIRAL RIVETED WATER PIPE.—Catalogue of the Abendroth & Root Manufacturing Co.; 4to., pp. 39.

Fully illustrated descriptions of the various methods of connecting and the specials used with this pipe. The catalogue also contains a series of well-executed photo-engravings of points at which this pipe has been laid.

GENERAL SPECIFICATIONS FOR THE CONSTRUCTION AND MAINTENANCE OF INTERLOCKING SIGNALS AND SWITCHES. Union Switch & Signal Co., Swissvale, Pa. 12mo., pamph., pp. 22.

This is a useful and thoroughly admirable publication, having no connection whatever with the selling of signals, but only with their proper care. It is designed to be issued to employees concerned by the general manager or other officer of each railway, and is provided at the back with a blank for his authorization. It opens with a few pages of specifications as to the "General Principles of Signaling," such as form of signals and their arrangement. This is followed by specifications for construction, and this in turn by general instructions for the use of interlocking signals.

The rules give clear evidence of having been very carefully studied, with a view to giving every necessary fact in the fewest possible words. They may, therefore, be called almost a treatise on signaling in little.

CAR COUPLERS.—The Hinson Car Coupler, Chicago, Ill., Manufacturers of Passenger and Freight Car Couplers. Small 8vo., pamph; pp. 9.

The Hinson Co. is among the oldest manufacturers of automatic couplers of the M. C. B. type. The newest style has top unlocking gear, especially designed to allow the maximum travel of the drawbar without the use of a long chain.

CONTRACTORS' SUPPLIES.—Catalogue of the Ames Plow Co., of Boston, Mass., for 1892.

This catalogue gives illustrations and list prices of carts, rollers, plows, scrapers, forges, and all manner of smaller goods used by the contractors.

SOCIETY PROCEEDINGS.

WASHINGTON STATE IRRIGATION ASSOCIATION.—An association with the above name was formed at North Yakima, Wash., on March 10, with W. H. Peterson, Ellensburg, President, and R. Strobach, Yakima, Vice-President. Meetings will be held on the first Monday of October each year. The convention adopted a resolution favoring the cession of all arid lands to the states in which they are located.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—The twelfth annual meeting was held March 8, President Gobeille in the chair, 34 members and visitors present. The annual reports of officers were read. The retiring President read an address on "The Financial Status of the Engineer." The following officers were elected: President, Walter P. Rice; Vice-President, Albert H. Porter; Secretary, Charles S. Howe; Treasurer, Cyrus P. Leland; Librarian, Charles H. Benjamin; Directors, Charles H. Strong and Gustavus A. Hyde.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The annual meeting was held March 16, at the Massachusetts Institute of Technology, President F. P. Stearns in the chair; 73 members and 45 visitors present. Three members and one associate were elected.

The several annual reports showed a net increase of 25 in members, the total membership being now 290, and a gain of over $634 in the funds. Ten regular meetings have been held during the year with an average attendance of 73. The result of the ballot for officers for the ensuing year was as follows: Pres., Henry Manley; V.-P. (for two years), Albert F. Noyes; Secy., S. Everett Tinkham; Treas., Edward W. Howe; Lib., Frank W. Hodgdon; Director (for two years), Frederick Brooks. An address was given in the evening by Mr. Thos. C. Clarke, on "The Progress of Bridge Building in the Last Fifty Years."

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on March 16, Mr. Arthur Winslow presented a paper on "The Progress of Mapping in Missouri." The paper sketched the history of map making, and showed its connection with the advance of civilization. The early attempts at maps of North America were described and copies of these maps exhibited. The early maps were extremely curious, and the series showed not only the increasing knowledge of the country, but also the greater ability of the surveyors. In more recent times the work was begun by the United States Coast Survey, in 1871 with a triangulation across the state. In 1882 precise leveling was carried across the state. The Mississippi River Commission had carried the work on along the river. The Missouri River Commission had followed the Missouri River. The U. S. Geological Survey, from 1884 to 1889, mapped about one-third of the state in the central part. The state Geological Survey is at present engaged in mapping the state chiefly for geological purposes. Specimen sheets were exhibited, showing the nature and character of the work.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—Meeting of March 15. The subject for discussion was the paper on "Smoke," read at the last meeting by Mr. William Metcalf and reported in Engineering News of Feb. 27. Prof. J. W. Langley admitted that the heat necessary for puddling furnaces, etc., could not be produced without smoke; but he argued from physical principles that there should be but a small amount of smoke. The principal source of trouble was from boiler fires, and he thought mechanical stokers would relieve this, though the cost was excessive for small establishments. Dr. Daly took up the question of the effect of smoke on health, and he thought that no one would contend that the human anatomy was designed as a smoke consumer. The carbonaceous particles of smoke have a most irritating effect upon the lungs and produce consumption of the most incurable type. Examination of the lungs of deceased Pittsburgers show that these are usually of a dull red, mottled color. These mottled lungs went out of fashion to some extent during the natural gas era, but they are coming in, said Dr. Daly. The Pittsburg death rate is higher than that of Cleveland, St. Louis, Chicago, Buffalo, Detroit, Milwaukee, Louisville or Indianapolis. But the death rate was 1.62 per 1,000 less in 1884-89, or the natural gas period, than at any other time.

ENGINEERING ASSOCIATION OF THE SOUTH.—The March meeting was held at Atlanta, Ga., March 11, the President, Mr. A. V. Gude, and 20 members and 30 visitors present. The non-resident members and guests reached Atlanta March 10 by a special train over the Nashville, Chattanooga & St. Louis R. R. The trip from Chattanooga over the Western & Atlantic R. R. was made in charge of Mr. Hunter McDonald, Res. Engr., and the train made numerous stops at the improvements on track and bridges now being carried on, including between 20 and 30 iron bridges, the rebuilding of a large proportion of the masonry for them, the reballasting of a considerable portion of the roadbed and the beginning of the relaying of the track with heavy steel rails. On the 11th an electric car was placed at the disposal of the Association by the Consolidated Street Ry. Co., and the forenoon was spent in visiting the principal points of interest in the city, the greater amount of the time being devoted to the inspection of the new plant of the Electric Lighting & Power Co.

At the meeting in the afternoon the business was introduced by President Gude welcoming the Association and guests to Atlanta, outlining briefly the status of the Association and the engineering profession of the South. A communication was received from Mr. Octave Chanute transmitting a prospectus of the organization of the International Congress of Internal Water-ways and extending an invitation to attend the fifth annual meeting of this congress, to be held in Paris, France, beginning July 21 and continuing ten days, the congress to be preceded and followed by excursions to the systems of canals in northern and central France.

Mr. Hunter McDonald, Asst. Engr., W. & A. R. R., then presented a paper on "Steel Rails," giving the history, chemical analyses, rate of wheel-wear, results of bending tests and of tensile tests of three steel rails laid at different times on the N. C. & St. L. R. R. Mr. A. V. Gude presented a paper on "The Granite Quarries of Lithonia, Ga.," giving comparative results of the crushing strength of granite from different quarries. An interesting point brought out by the paper was the method of "lifting" a quarry or producing an artificial bed covering acres in extent by a single blast hole, a method discovered in the Georgia quarries a few years since.

On March 12 the party visited the granite quarries at Lithonia, and the Georgia Technological Institute.

NEW YORK RAILROAD CLUB.—A regular meeting of the club was held March 17 at the rooms of the American Society of Mechanical Engineers. A paper on "Economies of Maintenance of Way" was read by Mr. Benjamin Reece, in which he showed that it is not enough to use heavier rails and fastenings to effect improvement and remedy defects in the track, but that very great improvement can be effected by thorough and systematic work on the roadbed, ballasting and ties. From statistics in regard to groups of important railways in several states, he showed that while ten years ago the annual expense for the renewals was about half that for rail renewals, it is now twice that for rail renewals. Very thorough work should be done in tamping, and the renewals should be carefully made. Some years ago, when in charge of maintenance on 900 miles of track, he ordered that all ties removed should be kept for his inspection, and he found a very large number removed prematurely. He suggested that this personal inspection is a good plan to effect economy, and is an object lesson to the track foremen, the men who have to decide what ties are to be removed. Many ties, especially those of soft wood, are removed on account of rail cutting, but this can be largely prevented by the use of steel tie-plates. When connected with the Lake Shore & Michigan Southern Ry., he required daily reports to be made, showing the time of work and the amount of work done. In this way he was able to arrive at the average amount of work of different kinds per day, and also to see if the men were working properly. A similar system is now in use on the Denver & Rio Grande R. R.

In the discussion, Mr. Forney referred to the valuable system of detailed track reports instituted by Mr. Albert Fink on the Louisville & Nashville R. R., the value of which system of reports is not generally recognized. Mr. Sinclair said it proves to be expensive to be too economical in track work, and referred to an old system of having the maintenance done by contract at so much per mile. The contract generally ran for ten years, at the end of which time the track was in very bad condition. One member referred to the very varying opinions upon track details, instancing the use of angle bars 16 to 54 ins. long. Referring to the Boston & Albany 95-lb. rail, with head 3 ins. wide, he thought it liable to have the outside of the head crushed by the outer flange of "double-flange" worn car wheel tires, and this led to some discussion on wear of tires, and the effect of brakes in causing even wear and reducing the necessity for frequent turning of the tires. The general practice appears to be to limit the wear to 1-4 in.

After the discussion a resolution was passed expressing sorrow at the death of the late Mr. Ross Kells, Superintendent of Motive Power of the New York, Lake Erie & Western R. R.

A short paper on the Fox pressed steel truck was then read by Mr. Brady, claiming that it is easy of inspection, has only one-third the number of parts of the ordinary diamond truck, and is superior in many ways to any other form of freight car truck now in use. The steel plate is of 60,000 lbs. tensile strength. The rivets are not found to work loose. A large number of roads are trying these steel trucks. Mr. Forney considered this a very promising form of truck, and that the arrangement of springs over the axle boxes instead of between them, as in the diamond truck, is a good one. A similar arrangement was introduced in some early Boston & Albany freight car trucks. As to corrosion of the metal, there is no trouble experienced with diamond trucks having channel-bar transoms, and in any case this could be provided for by special paint or a preservative treatment of the metal. The steel truck was discussed at the New England Railroad Club, March 9, (Eng. News, March 19).

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 1. Secy., E. K. Smoot, 808 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 1. Secy., O. von Geldern, 819 Market St., San Francisco.

ENGINEERS' CLUB OF PHILADELPHIA.
April 2. 1122 Girard St. Secy., J. C. Trautwine.

SWEDISH ENGINEERS' CLUB.
April 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
April 2. Union Station, St. Paul.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 4. Secy., C. L. Annan.

WESTERN SOCIETY OF ENGINEERS.
April 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

ENGINEERS' CLUB OF ST. LOUIS.
April 6. Secy., Arthur Thacher, Odd Fellows' Building.
"Steam Shovels and Steam Shovel Work," E. A. Hermann.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 6. Secy., F. Collingwood, 197 East 23d St., New York.
"Brooklyn Intercepting Sewer," Willard Beahan.

ENGINEERS' CLUB OF MINNEAPOLIS.
April 7. Public Library Bldg. Secy., F. W. Cappelen.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 8. Union Station, St. Paul.

TECHNICAL SOCIETY OF NEW YORK.
April 9. 194 Third Ave. Sec., H. Schreiter.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 9. At Roanoke. Secy., J. R. Schiek, Roanoke, Va.

ENGINEERS' CLUB OF KANSAS CITY.
April 11. Baird Building. Secy., H. Goldmark.

WISCONSIN POLYTECHNIC SOCIETY.
April 11. Loan & Trust Bldg., Milwaukee. Secy., M. Shinke.

DENVER SOCIETY OF CIVIL ENGINEERS.
April 13. Secy., Geo. H. Angell, Jacobson Block.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., Parker N. Black, Capitol Block.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 13. Secy., A. H. Porter, 50 Euclid Ave.

NORTHWESTERN SOCIETY OF ENGINEERS.
April 12. Occidental Block, Seattle. Secy., E. H. Warner.

ENGINEERING ASSOCIATION OF THE SOUTHWEST.
April 14. Secy., O. H. Landreth, Nashville, Tenn.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 14. Secy., Edward Mead, Norton Building.

MONTANA SOCIETY OF CIVIL ENGINEERS.
April 16. Secy., F. D. Jones, Helena.

WESTERN RAILWAY CLUB.
April 19. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 19. Secy., J. H. Harlow, Pittsburg, Pa.
"Hydraulics of Large Rivers," Geo. S. Davison.

BOSTON SOCIETY OF CIVIL ENGINEERS.
April 20. Secy., S. E. Tinkham, City Hall.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 21. Secy., C. H. McLeod, Montreal, P. Q.

ENGINEERS' CLUB OF CINCINNATI.
April 21. Secy., J. F. Wilson.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 21. Secy., T. G. Phlfeldt, 113 Adams St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 21. At Atlanta, Ga. Secy., F. A. Charplot, Macon, Ga.

NEW YORK RAILROAD CLUB.
April 21. Secy., H. G. Prout, 73 Broadway.

NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.

CENTRAL RAILWAY CLUB OF BUFFALO.
May 25. Secy., Jas. Macbeth.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

A correspondent in another column calls our attention to the fact that in describing the Ogden Avenue Viaduct, of Chicago, Ill., in Engineering News of Feb. 6, 1892, we neglected to state that the plans and specifications for this structure were prepared under the personal supervision of Mr. A. W. Cooke, then City Engineer, from designs furnished by Mr. John Lundie, Consulting Engineer of Chicago. We take pleasure in giving this correction prominence, wishing in this instance and in all others, to give full credit to all those concerned with engineering works which we describe.

Users of bearing metal alloys will find information of interest and practical value in the paper of Dr. Chas. B. Dudley, published elsewhere in this issue, describing the experiments which have been made on the Pennsylvania R. R. in the search for the best alloy for car bearings. The alloy which has been adopted is a bronze containing copper, tin and lead, in the proportions of 77, 8 and 15. Extensive experiments have shown that its rate of wear as compared with the old-fashioned bronze containing 7 parts of copper to 10 of tin is as 58 to 100, and it is stated to give no more trouble by heating. It has also been tested in comparison with some of the best of the patented bronzes and showed somewhat superior results, as elsewhere abstracted. Its tensile strength is rather low, only 24,000 lbs., but it is designed for a bearing metal only, and so far as we know has not been tested except in the journal bearings of railway rolling stock. The cost of this metal at present market prices is about 10 1-3 cts. per lb., whereas the cost of the old-fashioned 7 to 1 bronze is about 11 2-3 cts. per lb., and some of the patented bearing metals, on which many engineers are accustomed to rely, are sold at prices far above this figure.

A pertinent question with regard to this alloy is whether it wears the journals faster than other metals. No experiments on this point have been made, but it is probable that any notable difference in this respect would have been discovered, since the new alloy has now been in use some time. It is practically certain that there is considerable difference in bearing metals with respect to wear on the journals; but the laws which govern this variation, so far as we know, are still undetermined. The fact is, that technical literature contains very little information on the subject of bearing metals, considering its importance. The difficulty involved in making any comprehensive investigations of materials varying so greatly as do the alloys, is the probable reason why most of the knowledge concerning them has been gained by shop experience. Now, experience is a most valuable teacher, but the lessons she gives need correct interpretation; and in such a difficult subject as the relative merits of alloys the user does not always interpret his experience correctly. For example, machinists differ greatly in their opinions and practice concerning the use of Babbitt metal; the reasons are not hard to find, for what one man uses under that name may differ widely in composition and character from that used by another; and a metal which would give good results in a dust-proof bearing might prove a failure when exposed to dirt and grit.

Thus while shop experience can prove the worth or worthlessness of a particular metal for a particular use, it is not easy to generalize from it and discover what qualities in a bearing metal cause it to wear slowly. Dr. Dudley thinks the experiments made on the Pennsylvania Railroad tend to show that the rate of wear is decreased as the metal is increased in percentage of elongation and also in tensile strength; also that metals of fine granular structure wear slowest. He only gives a hint, however, of any law governing the rate of wear of journals, suggesting that a reason why hard metals like cast iron are not used for bearings is that they might wear the journal too rapidly. It is probably true that either very hard metals or metals so soft as to allow particles of grit to imbed themselves, will cause rapid journal wear, but more accurate knowledge than this is needed. The practical limitations in the running of high-speed machinery are frequently found in the heating of bearings and the cutting of the wearing surfaces.

Mr. Lewis' paper on "Soft Steel in Bridges," which we begin on another page, is an interesting contribution to the discussion of the question how far soft steel can be trusted. It is to be regretted that the paper did not call forth a more general statement of the views of engineers who still hesitate to place soft steel on a par with wrought iron in their work. Certainly every engineer is interested in knowing the basis on which a discrimination is made against soft steel or steel made by any especial process; if the metal we are using for bridges and other important structures is in any degree untrustworthy, the evidence in proof of it ought to be generally known.

Only one member, in the discussion of the paper, ventured to criticise the use of soft steel; and his position we understand to be somewhat as follows: Steel is a crystalline metal; iron is a fibrous metal. Even the softest steel retains to some extent the brittleness characteristic of the hardest. It is true that it will stretch farther before breaking than iron and will endure a greater strain without taking a permanent set; yet it has the crystalline structure, and a scratch, a bruise or an incipient crack too fine to be seen may extend and develop and under vibratory strain may finally cause fracture.

Now, statements like the above are deserving of consideration. To what extent are they correct, and to what extent mistaken? It is certainly reasonable to believe that a crack will progress more readily in a homogeneous metal like steel than in a non-homogeneous metal like iron; and it must be left for practical experience to decide how much weight is to be given to this argument against steel.

Perhaps the best evidence on this point which can be found is in the results obtained from putting a screw-thread on steel. Of course to put a screw-thread on a rod is practically to make a nick, and a good deep one, all round it. Mr. Lewis describes tests of steel eye-bars, 5x3-4 in. in section, which were upset to form a round end, and a screw-thread for a turnbuckle was made upon it. These bars were then broken, the fracture occurring in no case at the screw-thread. Similarly tests of steel stirrup hangers with but 7 per cent. excess of cross-section at the root of the thread broke in every case at other points than the screw-thread. It seems fair to conclude that cutting a screw-thread on steel does not materially affect the strength of the metal beneath, at least to withstand steady strain.

It seems to us that another piece of important evidence as to the ability of steel to withstand abuse, is the increasing use of steel for pipes and tubes in place of wrought iron. Notwithstanding the objections of those who would not use steel for pipes, because they believe it could not be welded, and those who said it cost too much to cut the threads on steel pipes, steel is being used more and more in place of iron for pipe making. Recently the National Tube Works Co., the largest maker of wrought metal pipe and tubes in this country, has announced its intention of erecting a Bessemer steel plant with about 800 tons daily capacity to supply their works with "skelp," or strips for making the tubes.

It seems safe to say no such substitution of steel for iron would be made if the former metal was more injured in the operation of threading than the latter. It is to be remembered that cutting a thread on a pipe makes a much deeper nick in proportion to the strength of the piece than cutting a thread on a solid bar.

THE PROPOSED DEFACEMENT OF CENTRAL PARK.

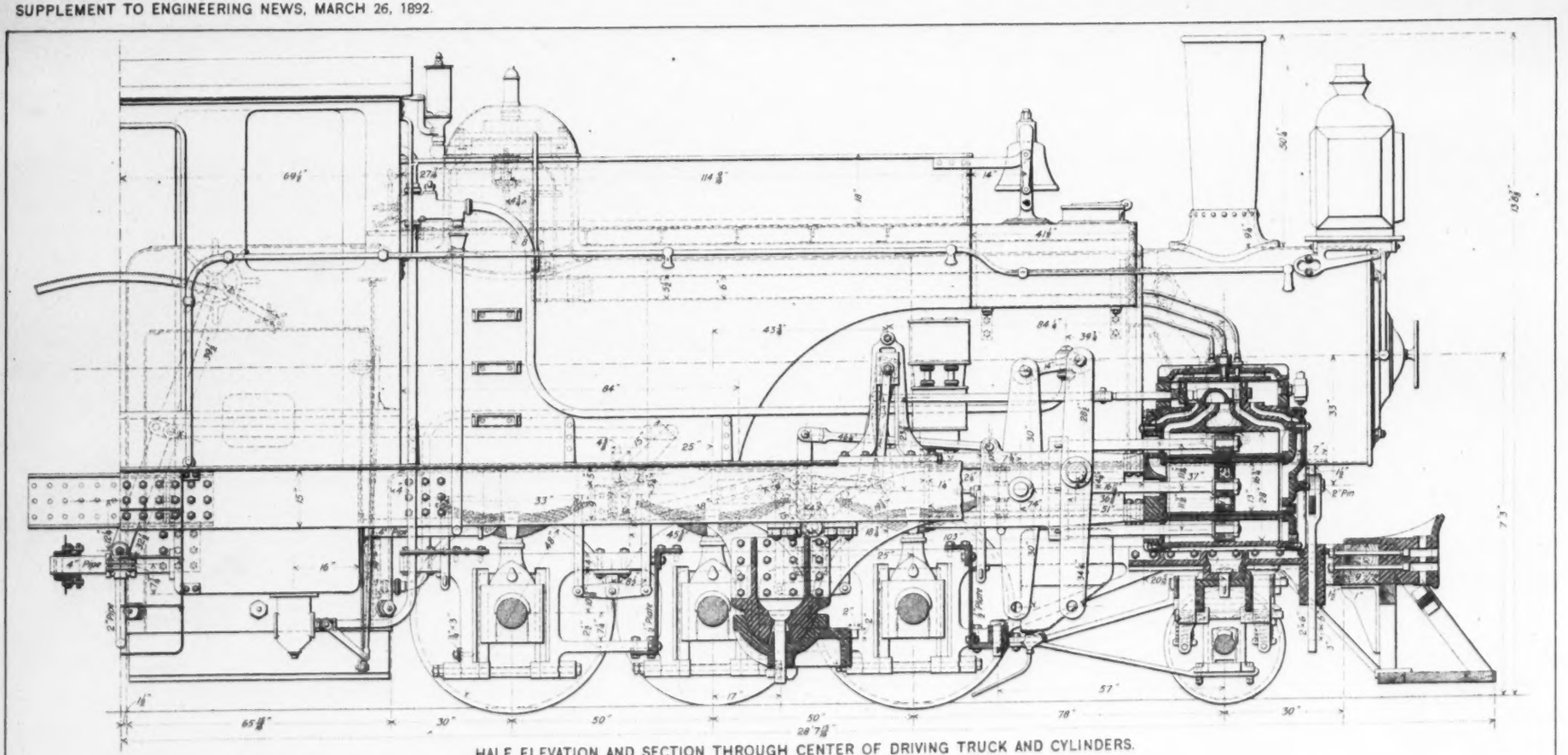
Within the past week we have had another gratifying proof that "the fault is not in our stars, but in ourselves, that we are underlings" to the corrupt combine which, in all small matters, holds undisputed sway over the affairs of this city. Since our last issue was in type an astonished city has seen a measure for constructing a race track in Central Park rushed through both houses of the Legislature without discussion, signed by the Governor, ordered to construction by the Park Commissioners and then practically reconsidered and abandoned after only one full day of public indignation had done its work. The course was to have been 70 ft. wide and anything less than 2 1-2 miles long which the Park Commission pleased, the same body being also given unchecked discretion to "alter the plans," and to add "such loops and connections as may be necessary," in its valuable judgment.

Such uncommon anxiety to forestall public opposition clearly shows that there was a strong lobby behind the bill, managing the Governor, Senate, Assembly, Mayor and Park Commission alike. After the bill had been rushed through the Senate the day before, on "St. Patrick's day in the morning," it was rushed through the Assembly also without debate, by a majority of 68 to 25. The Governor had been duly notified to be in attendance and sign the bill, which he did 3 min. 49 sec. later. A Park Commissioner had also been duly stationed at the other end of a wire to New York, and he instantly called a special meeting. Early next morning (March 18) the meeting had been called, held, passed a resolution asking for money and ordering the route to be staked out, and had adjourned! By an unconscious bit of sarcasm on their own indecent haste, their resolution ordered their engineer to (first) "stake out the route and" (then) "make the necessary surveys!"

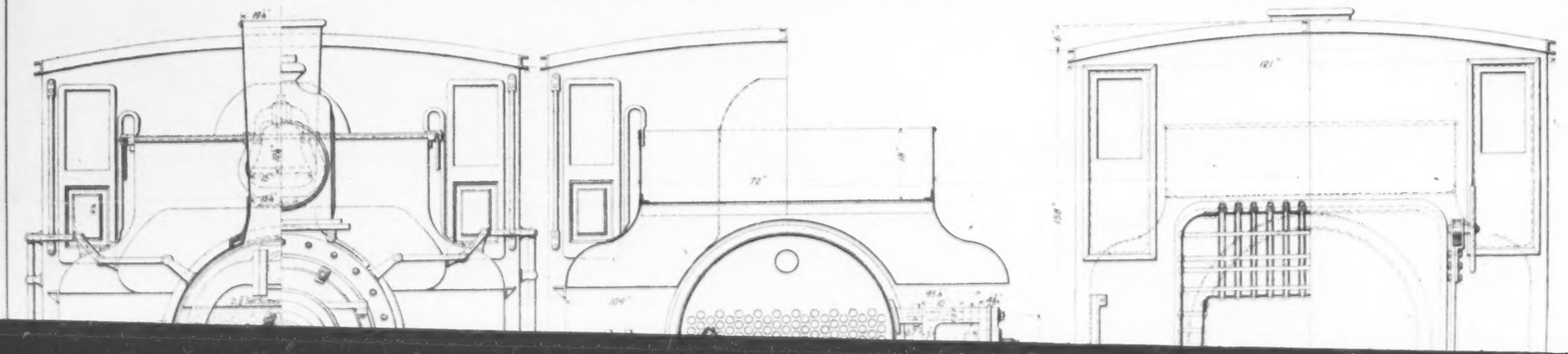
But the same people which has again and again quietly submitted to bills for squandering millions of its money, and doubtless would have submitted once more, had a few millions of money more or less been the only issue, rose in its wrath. An organized opposition, sprang into existence as if by magic, and had a "secretary" appealing to the public for names in opposition within 24 hours. So determined and unanimous was the expression of the popular will that, on the second business day after their action had been taken, the Park Commission withdrew it in confusion, and it was clear (at least it seems so to us) that in a few days more the measure will be wiped off the statute book as an effect of popular pressure.

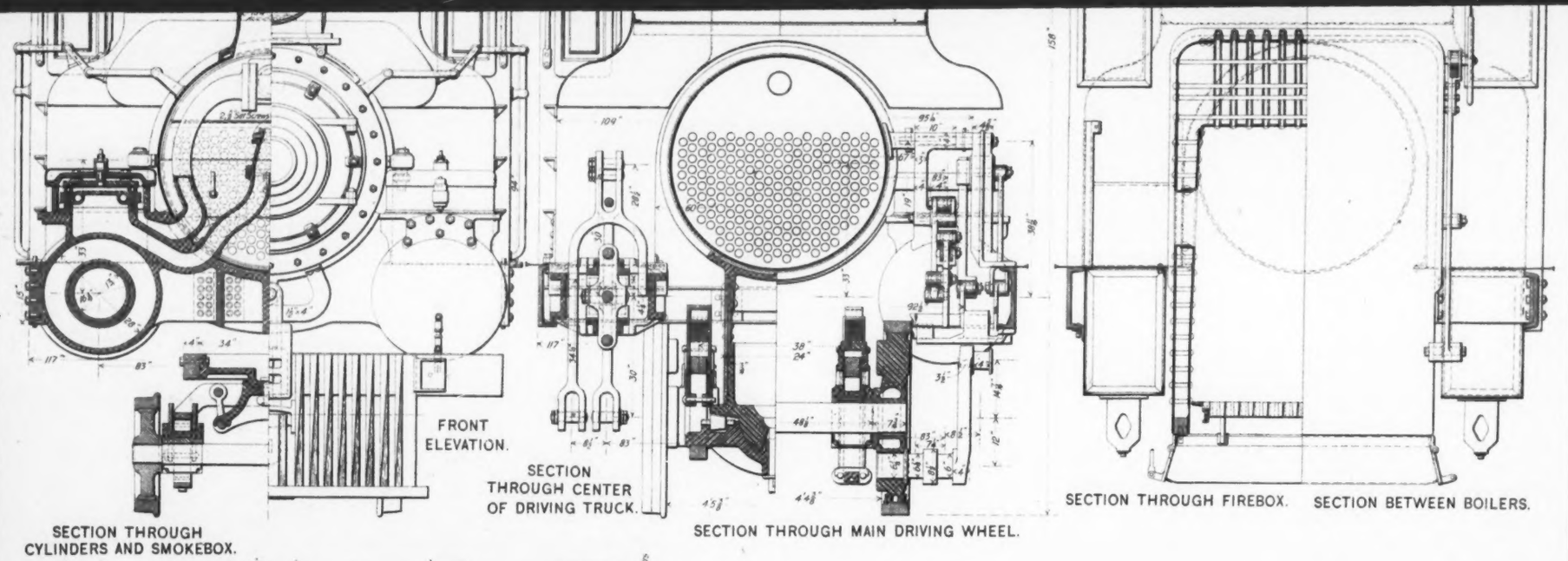
The underlying motives for this soon-exploded plot are hard to see. In this particular instance they were perhaps not venal. The combine which rules this city was doubtless not unwilling to have an excuse for putting a few more "laborers" on the city pay rolls in a presidential year; but its main motive, we take it, was a desire to gratify that love of fast horses and fast driving which it shares with many better men and with all classes of toughs and social outcasts. They saw no reason why they should not gratify this love, because they were honestly unable to appreciate what injury their scheme would bring to the beauty and the charm of Central Park. It is perfectly natural that a man who has chosen the career of a New York city politician should be unable to feel that charm.

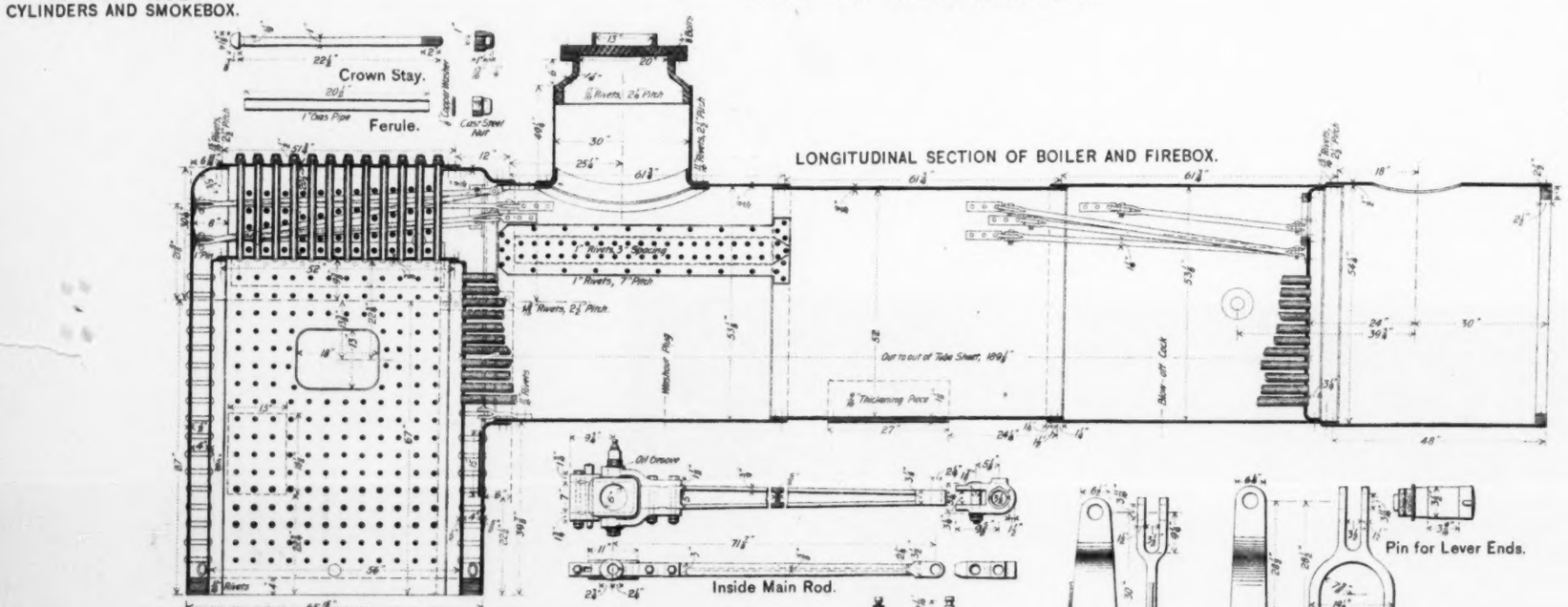
It is again clear that the people feel it, but we fear that even among the strongest opponents of this

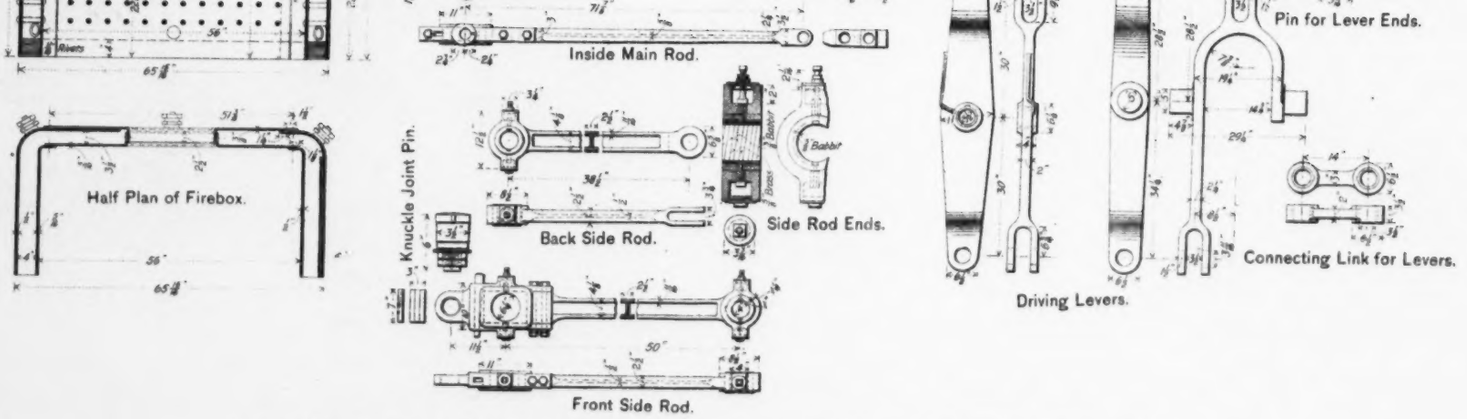


HALF ELEVATION AND SECTION THROUGH CENTER OF DRIVING TRUCK AND CYLINDERS.




FRONT ELEVATION.
SECTION THROUGH CENTER OF DRIVING TRUCK.
SECTION THROUGH FIREBOX.
SECTION BETWEEN BOILERS.
SECTION THROUGH CYLINDERS AND SMOKEBOX.
SECTION THROUGH MAIN DRIVING WHEEL.

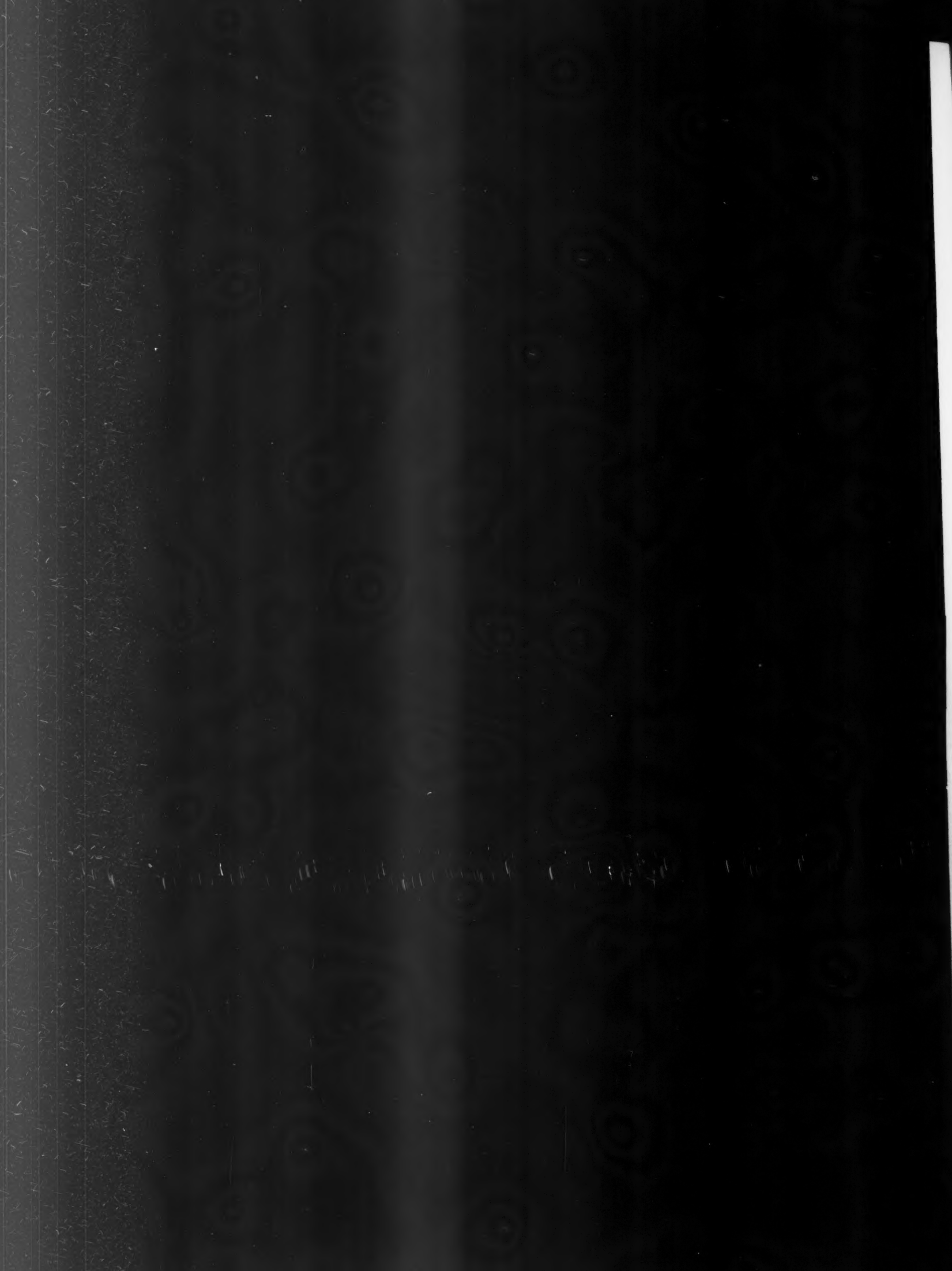

Crown Stay.
Ferule.
LONGITUDINAL SECTION OF BOILER AND FIREBOX.
Inside Main Rod.
Pin for Lever Ends.



DOUBLE-TRUCK COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

F. W. Johnstone, Superintendent of Motive Power and Machinery.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.



measure there are some whose opposition is more instinctive than reasoning; who hardly appreciate the reasons why any such meddling with the park, as it now is, is peculiarly certain to be injurious. It may perhaps do good, therefore, and certainly ought to be of interest at this time, if we particularize some of them, especially as these spoliating projects are certain to spring up again from time to time, in the future as in the past.

The truth is—and it is an instinctive appreciation of this truth which makes the attitude of the people so determined—the truth is that Central Park, in a peculiar sense, is a single and a perfect work of art, as no other great park in the world is; and as such it is as incapable of spoliation in one part without injury to the whole as is any other work of art. Unfortunately, in designing any public pleasure ground the highest art is to conceal art; to make every vista and landscape look as unstudied and as accidental as possible; and so successfully has this aim been achieved in Central Park that it is only as a charming bit of nature in the midst of a city that most people think of and visit it. If it were nothing more than this, to slice off a fraction of its area might be unwise, but it also might do as little harm to the rest as to slice off 2 or 3 per cent. of a bit of country woods or meadow.

But it is not such. Alone among the large city parks of the world, Central Park was planned from the beginning out of nothing, and planned as a whole, to meet a number of unfavorable limiting conditions, some of them very severe. In the first place, because of the form of the island it had to be made long but very narrow, 1-2 mile wide by 2 1-2 miles long, and this narrowness had to be concealed so far as possible. In the second place, its boundary was a rectangle, fixing without regard to topographical features. In the third place, 142 out of its 840 acres had to be surrendered to a reservoir, which nearly cuts it in two, coming within a couple of hundred feet of its east and west boundaries. In the fourth place, as if this were not enough, four transverse streets for traffic had to be carried through it, since business traffic across the city could not be completely cut off for a distance of 2 1-2 miles, and yet could not be permitted in the park. At least it could not be permitted without destroying its sylvan and park-like effect, as is now very clear; but when competitive designs were first asked for, none but those whose design was preferred and carried out, Fred Law Olmsted and Calvert Vaux, appreciated this necessity.

Finally, as this was to be a people's park, lying in the very heart of a great city, it was necessary to provide for unprecedented crowds of visitors of three different classes, on foot, on horseback and in carriages, and to enable each class to enjoy the park with the minimum of interference with the others.

Now if the reader who may have the other great parks of the world in his mind, will take occasion to make a visit to Central Park, not to enjoy, but to study and appreciate, he will be filled with admiration at the way in which all these difficulties have been met, and all these results achieved, to an extent which is quite without parallel among others great parks, by a combination of profuse expenditure and of a delicacy of taste which amounted to genius. He will be greatly aided in this study if he also goes to the park museum and there studies the six or eight competitive models which were submitted when the park was first designed, and show what the park might have been in other hands.

The four transverse roads have been so skillfully carried across the park above or below its surface that many visitors cross them repeatedly and come away without noticing that they exist. The separate systems of walks, bridle paths and driveways are so complete that whichever one the visitor is on seems to be the principal feature of the park, and the other two merely adjuncts, and it is almost like seeing a new park to go from one to the other. The narrowness of the park has been so effectively concealed (except as the modern high buildings reveal it) that few visitors have any suspicion that its narrowness was one of the serious elements of the problem, and an impression of magnitude is so skillfully sought for and obtained, that nine visitors out of ten, we believe, who had no map and knew nothing about either park except what their eyes saw, would come away with an impression that it was larger than the Bois de Boulogne of Paris. We know of one very critical observer who did so; and yet that famous park covers 2,250 acres, while Central Park only has 840 in all, and only 698 acres, in two blocks nearly a mile apart, after the reservoirs are deducted. Moreover (and here we come to a fact which is absolutely without precedent among great parks which seek to get a similar rural effect, and which few visitors indeed suspect), not less than 113 acres of this 698 is actual paved area, occupied by rides, walks and driveways, there being no less than 50 acres of carriage ways, 39 acres of walks and 15 acres of bridle paths in the park.

This unreal effect of spaciousness, this pure illusion of ample width and area, is precisely what tempts these repeated attempts to "improve" this or that part of the park, or do something more or different with it, and yet it is precisely this which the proposed race track would destroy for all the lower part of the park. Why it would do this we shall quickly see when we come to consider some of the means by which the result was achieved; but before we do this, let us see how the senses are cheated in another way by the art of the designer.

In Boss Tweed's day a plan was made and almost carried out (honest in intent we do not doubt) to "improve" one of the great meadows by putting a handsome sheep-house in the center of it. Very recently also we have been treated to another project to "improve" the same meadow. Very recently also we have been told that the "unimproved" meadows in the upper park were just the place for a World's Fair. Still more recently our cultured Mayor has informed us that some ground which the proposed race track would "improve" was also in an "unimproved" condition. The feeling that there is endless room in Central Park for this, that or the other use is very common, and above all, there is among improvers and non-improvers alike an all but universal feeling that there is no end of meadow space. Few visitors indeed go to the park without being impressed at their first visit by the great meadow vistas, and many tolerably civilized visitors no doubt agree with Tammany that "something ought to be done with this waste space."

Now, does the reader know how much meadow space there really is in Central Park? Not ten men in New York know; and not a single man could guess within a hundred acres, nor many within two hundred, if he did not know. There is just 55 acres! That is the entire area of those great expanses which men see over and over again from different points of view, and think, or rather feel, each time is something new. To this is to be added 54 acres of minor open spaces, making only 109 acres of grass land in all, against 113 acres of bare roadways, and over 400 acres of rocks and woodland! To account in a single statement for every inch of area, there is in the park:

	Acres	Acres
Original area taken for the park, less three acres, as thrown into exterior walks.....		840
Of which the reservoirs absorb 17 p. c. or....		142
Leaving of the park proper.....		698
Of this, there is in roads, walks, drives and transverse roads, 16 p. c. or.....113		
In six lakes (largest 20 acres), 6 p. c., or..... 42		
In large meadows, 8 p. c., or..... 54		
In small turf areas, 8 p. c., or..... 54		
In bare rock surface, 3 p. c., or..... 24		
In woods and plantations, 59 p. c., or.....409		698

Per cent. of original area given up to reservoirs, roads, walks and drives.....	31 p. c.
To large and small grass areas (half each).....	13 "
To roads and plantations, rocks or water.....	56 "

In other words, a third (!) of the area of Central Park is already occupied in non-effective, nay, injurious ways, so far as its rural park effects are concerned, and yet it is thoroughly rural and park-like in every part! and yet the legal guardians of this park, out of their ignorance and hardness of heart, would take away still more! In what other great park can be found such economy of space; such creation of something out of nothing, such a complete conquest of difficulties greater than the designer of any other park has had to cope with? It cannot be found. It is absolutely beyond precedent. We wish we had space to give the figures which lie before us as we write, and which we had intended to give, to show this in detail, but we cannot in this issue, as in our remaining space we must rather show how fatally the proposed race track would injure some leading means by which this result has been achieved.

The effect of spaciousness, and especially of width, has been sought in many ways, but chiefly in these three. The first, a commonplace of landscape architecture, was to plant the edges of the ground. It needed no great genius to devise this obvious yet most necessary artifice, and yet it is precisely these plantations which the proposed race track would whack into and destroy. A second measure of great importance, which has been used with consummate art, was to eliminate by convolutions in the roadway all evidence of the rectangular outline of the park, and especially of its extreme narrowness. This was chiefly necessary for the carriage roads and bridle paths, because the visitor on foot moves too slowly to be affected by it. It is an education in landscape art to drive around the park and notice at each end of it how completely the desired effect has been produced, not by the clumsy remedy of making the roads as long as possible by keeping to the corners, but by making the visitor drive a mile or so after he has seen one corner, for good apparent reason, before he sees the next one.

The third device, and one which more immediately concerns us, is of a complex, or we might rather say a duplex nature. In order to produce an effect of ample area it is on the one hand necessary to keep as near to the boundaries as possible, in order to increase distances, and also to give many long vistas from many points of view; but on the other hand it is necessary to keep the walks, rides and roads well apart from each other and to keep a visitor on any one of them from seeing more than one boundary at any time, and from seeing (or realizing) any boundary most of the time.

The primary device for accomplishing these ends was a marked difference of treatment, which runs all through the park, between its interior and exterior areas. It is simple; it was not wholly new; yet it is without real precedent on any considerable scale and in its application it was a stroke of genius. On the interior areas broad, flat, open effects were sought (except for some special good reason, as with the Ramble), and sought at heavy cost. No such areas had previously existed. The original ground was very rugged and chiefly rock. The great meadow areas (of 55 acres) were obtained only by heavy blasting and grading.

But with all the exterior areas the very opposite was done. All the original irregularities were preserved and accentuated. Was the ground low? It was made lower. The lake area near Fifth Avenue and 59th Street is a typical example. Was it high? It was made higher, not indeed to so great an extent, but to some extent. Thus was preserved or created that fringe of highly irregular ground which, in conjunction with the aid to be had from planting, made it possible to throw three systems of pathways near to each other and to the border without any effect of crowding, but rather with the effect of leaving lots of ground still unimproved.

There never could be a better instance of this skillful creation of rural simplicity, space and quiet under difficulties, and for a purpose, than the very hill near 84th St., which Mayor Grant has had the hardihood to instance as a place which was "unimproved," and where a brand new graded race track would come in nicely! But it needs no special instance. The whole west side is an instance, as is the south side, and the east side, and the north side; and it is precisely this ground, this indispensable narrow fringe of protecting ruggedness, which it is proposed to whack into, grade down level and destroy.

We have no patience to consider further such a monstrous project, though there is much that we had meant to say, and would like to say, to make still clearer what a harmonious and studied work of art New York has in its apparent bit of country, and how impossible it is to change it materially in any part without defacing it. When New York permits it, it will be fitting, and less disgraceful, for it to let out the backgrounds and foregrounds of the paintings in its museum for the display of miscellaneous advertisements, as "unimproved portions" thereof. For in the whole world there is not a finer work of art than Central Park, and it is of more value than many pictures.

LETTERS TO THE EDITOR.

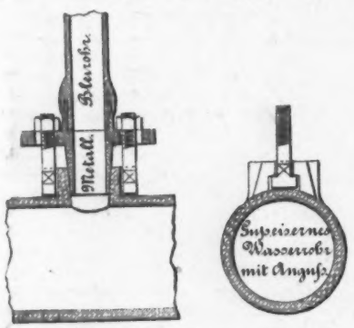
THE OGDEN AVE. VIADUCT.—CORRECTION.

Sir: In your article in Engineering News of Feb. 6, describing and illustrating the Ogden Ave. viaduct, Chicago, it should have been stated that plans and specifications for this structure were prepared under the personal supervision of Mr. A. W. Cooke, then city engineer, from designs made by Mr. John Lundie, M. Am. Soc. C. E., Chicago. Let honor be given to whom honor is due. Yours very truly,

Chicago, March 17, 1892. Frederick A. Peckham.

TAPPING BOSS FOR GAS AND WATER PIPE.

Sir:—In regard to an article entitled "A New Gas and Water Pipe," in your issue of Feb. 13, 1892, allow me to state that such pipes have been in use for



Device for Tapping Pipe through Boss.

the water-works in this city since about 1848. The accompanying drawing shows the style of pipe and the tapping device. Mr. Richardson, therefore, has not invented anything new. Yours very respectfully,

Hamburg, Feb. 29, 1892. Otto Iben.

THE LOWEST PRICES OF PIG IRON.

Sir: Allow me to call your attention to a little mistake in one of your editorials in the News of this date, which is apt to be widely copied in the daily press. Referring to the quotation of $9 per ton for pig iron ot Alabama furnaces, you say you think it "is about the lowest point that pig iron has ever touched in any part of the world." The "Iron Age" of March 10, in its cable from London, gives a quotation of Cleveland pig as low as 35s. 3d, which is equal to $8.57. I have no doubt that prices in Belgium, France and Germany are even lower than this. The price for Cleveland pig also is for delivery at the sea coast, while the Alabama quotation is at furnaces, with a freight rate of $2 per ton or more, to be added for delivery either at the sea coast or any important inland market point. The $9 Alabama quotation also is for grey forge iron, foundry grades being at least $2 higher. Yours truly, Wm. Kent.

New York, March 19, 1892.

(We noticed the same fact ourselves, after it was too late to make the proper correction, but as the above European quotations are themselves extraordinarily low, the $9 quotation remains in a sense "about" the lowest quotation on record.—Ed.)

SOME BROOKLYN BRIDGE CONUNDRUMS.

Sir: Any careful outside observer cannot but have noticed that, from the first step towards an improvement in the terminals of the bridge, in the spring of 1887, to the last exhibit of the Ex-President and Vice-President of Trustees of his plans lately on exhibition in the Real Estate Exchange in Brooklyn, there exists an unnamed, and as it were, veiled power behind the throne among the bridge authorities, who sometimes come forward, yet without the veil being entirely lifted. With an admirable finesse, his methods are concealed from those nearest him. The latter, as puppets, are worked by an invisible wire, the operator of which is not ambitious of appearing to direct things, so that the more substantial fruits of such direction remain with him. Witness the Emery fiasco: Who was personally interested, though unseen, in bringing about its failure? Note the reception of the plans of the first Board of Experts. What did that point to? Who was personally interested in their failure? Who was the unseen agent through which, by skillful tactics, such failure was accomplished? Whose plans, notwithstanding their previous rejection by these experts, were without a dissenting voice adopted by the Trustees, as their sole refuge from a dilemma, which they were assured offered no other outlet? Who made a catspaw of one of the Trustees in order to feel the public pulse, until such time as it indicated that it would be safe practically to unveil himself? Who so hoodwinked the second Board of Experts, that they could see nothing clearly but what had been put into the magic lantern for their special benefit? Finally, omitting the consideration of the architectural monstrosities, and the plans for extension southerly toward the Brooklyn City Hall and private ends, whose plans (virtually) were those recently brought forward for the bridge terminals, for which the Vice-President, as an extraordinary expert, was permitted, as a harmless method of regaining lost prestige, to masquerade before the public as author?

Meanwhile, has the public responded to the appeal thus made for their suffrages, by going wild over their plans; promising, as they do, to provide for 60,000 passengers per hour at a trifling outlay of from $5,315,000 to $7,875,000 for railway construction alone, and including buildings of some rental value, possibly, from $7,858,000 to $11,411,000?

On the contrary, is not the public wearied beyond patience at the evidence here presented, that the system of management by some score of volunteers has gone far enough, and that it is time to call a halt? Is it not plainly time to put the management under a single conservative professional head, and close the construction account with a structure, say with a capacity of 50,000,000 passengers yearly, which is enough for any single bridge?

A proper management would accept the inevitable, and, recognizing the signs of the times and that the great metropolis surrounding these waters will never be content with a single connecting link between its parts, whatever its magnitude or capabilities, would confine his efforts to securing others of these paying institutions, rather than, like the ambitious frog in the fable, seek to swell its proportions until it bursts in the struggle.

As I close this letter, I observe the following in the proceedings of the Board of Trustees at their meeting, March 14, in reference to the plans lately exhibited by Mr. Howell at his own real estate exchange:

"Mr. James moved that a vote of thanks be given Mr. Howell, and at the latter's suggestion, included the engineer of the bridge, who had prepared the plans. It was carried, and the meeting adjourned."

Brooklyn, N. Y., March 19, 1892. Conservator.

(We are quite unable to agree with our correspondent that it would be wise to "close the construction account" of the Brooklyn Bridge with a capacity of only 50,000,000 passengers yearly. With the present facilities it is possible to carry 25,000,000 to 30,000,000 without an inhuman amount of crowding, and at the present time 35,000,000 to 40,000,000 are being carried, we believe. Under the plans recommended by the first Board of Experts it is possible to increase the car dispatching capacity fully five fold over the present tracks at a very moderate expenditure, less than a fifth of that required for the plans lately put forward under Vice-Prest. Howell's name, and by adding a second pair of tracks above the first, this again can be doubled, so that 250,000,000 to 300,000,000 yearly could be carried more comfortably than 35,000,000 are now. Why then should the construction account be closed with the traffic awaiting almost any capacity? Moreover, the trustees "adopted" another plan (the so-called Barnes-Martin plan) several years ago, and have had an indorsement of it from a second Board of Experts for nearly two years, as practically workable and promising large increase of capacity. We have shown that this Board was badly mistaken, and that the plan is not workable, and does not promise any sensible increase of capacity. It would seem as if the advisers of the trustees should be able to grasp a truth thus pointed out to them without first throwing away a million or so in a practical trial, and the late bringing forward of a brand new set of plans (new so far as the public is concerned, though the plans were really before both Boards of Experts and rejected by them), would look as if they had at least begun to grasp it. But they are committed so many times over to their "adopted" plans that we await with some amusement the practical trial,which can hardly be escaped, and until then are indisposed to give any serious attention to the bridge problem.—Ed.)

NOTES AND QUERIES.

A correspondent, who is much interested in the subject of race tracks, asks for plans of an "egg-shaped" track. By this he means a kite-shaped track, with the small end omitted, and the "point" converted into a parabolic or transition curve. We have published much on the subject of race tracks, and from the data given in late correspondence, tracks of any form can be designed. But if any of our readers have constructed a track of the form desired, we shall be pleased to add it to our collection.

An inquirer asks for trustworthy information as to the durability of cast-iron water mains buried in the ground, or placed under water. He wants place and time of burial and condition of the pipe at the end of the period. Mr. Frederick Graff, in an article on the Philadelphia water supply (see Engineering News, April 23, 1887,) says that the first cast iron pipe used there was made by Samuel Richards in June, 1820, and laid at Broad and Market streets. These pipes were made of charcoal iron, and "were in constant use for 53 years." They were, of course, uncoated, and the inside was well filled with tubercles, as we know personally. In salt water good cast iron, even uncoated, will last for a century at least; but it often becomes soft enough to be cut by a knife, as is shown in iron cannon, taken up from the bottom of harbors after long submersion. Close grained, hard white metal lasts the longest in sea water, as the contained carbon is then chemically and not mechanically combined.

JOHNSTONE'S DOUBLE TRUCK COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

(With inset.)

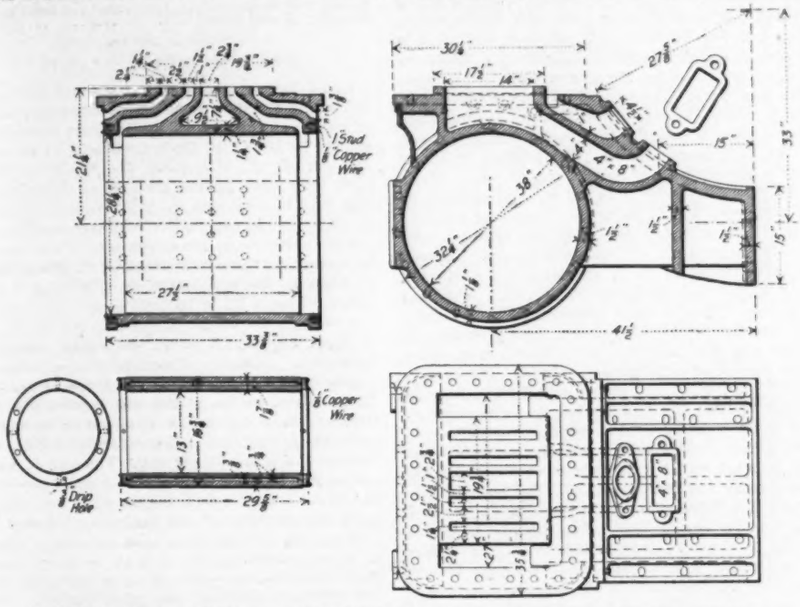
In Engineering News of March 12 was given an elevation and general description of the double-boiler, double-truck compound locomotive, designed by Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery of the Mexican Central Railway, and this week we present further details of this very interesting type of engine, of which three are to be built.

The boiler is of similar construction to that of Mr. Johnstone's ten-wheel compound locomotive which was described and illustrated in Engineering News, Aug. 29, 1891, except that the smokebox tube sheet is riveted directly to the Barrel plate of the boiler, the same ring of barrel plate being also extended into and riveted to the smokebox shell, instead of to a separate junction ring, as in the boiler of the ten-wheel engine. The boiler barrel is composed of three rings of 9-16-in. steel, 5 ft. 1 3-4 ins., c. to c. of circumferential seams. The middle ring is 4 ft. 4 ins. inside diameter, and the other two rings 4 ft. 5 1-8 ins. The front ring has the blow-off cock in the bottom and the injector check valve in the side, the opening for the latter having a reinforcing plate inside 7 ins. diameter and 1-2 in. thick. On the bottom of the middle ring is riveted an outside thickening plate 27 ins. long and 9-16 in. thick. The washout plug is in the bottom of the ring next the firebox. The waist of the boiler is made straight, and has a dome 30 ins. diameter, of 1-2-in. steel, which is similar to that of the other boiler above referred to. The throttle valve consists of two balanced poppet valves of cast iron in the vertical arm of the dry pipe. The boiler is made throughout of flange plates of Otis homogeneous cast steel, 3-8, 1-2 and 9-16 in. thick, the throat sheet 1-16 in. thicker than the shell. All horizontal seams in the shell are butt-welted inside and outside, and double riveted on each side of the seam with 1 in. rivets. All circumferential seams and the leg of the boiler are lap jointed, double riveted with 15-16-in. rivets, except that the back heads have a single row of 15-16-in. rivets. The foundation ring is double riveted, with 11-16-in. rivets. All parts are well stayed with extra welt pieces, riveted to the inside of the boiler. All plates are planed on the edges and calked with round nose calking tools. The boiler to be tested with hot water to a pressure of 200 lbs. per sq. in.

The smokebox is of the extension front pattern, with a deflecting plate, but no netting. The shell is of 1-2 in. steel and is 4 ft. 6 1-4 ins. inside diameter and 4 ft. 6 ins. long inside. The smokestack is of the plain pipe or "bootleg" pattern now so generally used; it is 15 1-4 ins. diameter at the bottom and 19 1-4 ins. at the top, the height from top to smokebox being 4 ft. 2 1-4 ins., and from the rail 13 ft. 8 7-8 ins. The center line of the smokestack is 2 ft. from the tube plate and 2 ft. 6 ins. from the front end. The tube plate has 1 1-4-in. stays to the boiler barrel plates.

The firebox is of the Belpaire type, but is very much shorter than that of the ten-wheel engine above referred to, although not being limited in width by being placed between the wheels it is made the full width between the frames. The size inside at the grates is 4 ft. 8 ins. by 4 ft. 8 ins.

while that of the ten-wheel engine was 10 ft. long by 3 ft. 5 ins. wide. The plates are of Otis homogeneous flange steel, annealed after flanging. The foundation ring is 4 ins. deep, with a double row of 11-16-in. rivets. The side and back plates are 5-16 in. thick; crown sheet, 4 ft. 6 ins. by 9 ft. 11-16 ins. by 3-8 in. Tube sheet, 1-2 in. thick. The water space is 3 1-2 ins. wide at the sides and 4 ins. at

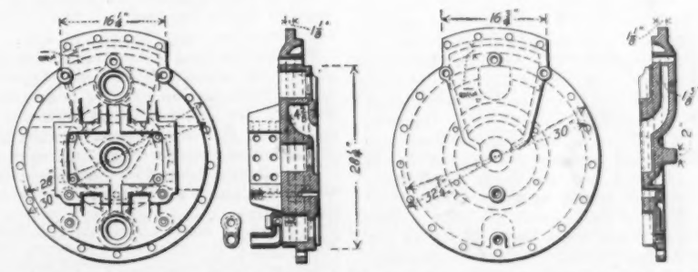


DETAILS OF CYLINDERS OF COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

the front and back. The three upper rows of stay-bolts are 1 in. in diameter, and all others 7-8 in; they are screwed and riveted to sheets and spaced not over 4 1-4 ins. c. to c. The back plate and the outside shell over the firebox are 1-2 in. thick. The back end brace rods are 1 1-4 in. diameter. The crown sheet is supported by through stay-bolts with cast steel or brass nuts. Bolts 1 in. diameter in body and thread, 22 1-2 ins. long under the head. with head and taper under the head formed in the die. They are spaced not over 4 1-4 ins. c. to c. The crown sheet is reamed to receive the taper of bolt, making a close fit and allowing the head of the bolt to touch the under side of the sheet when drawn up hard into place. Each stay is within a ferule or sleeve of 1-in. gas pipe 22 ins. long, fitting between the crown sheet and shell, and the nut or cap is screwed down on the outside of the shell, a 1-8-in. copper washer being placed between the nut and shell. The firedoor opening is rectangular, 13x18 ins., and is formed by flanging and riveting together the inner and outer sheets. The door is located in the left side of one firebox and the right side of the other, so as to bring both doors on the fireman's side of the engine. A tool guard is cast on the lower part of the door frame. The doors are made to slide from the center both ways. The grates have rocking bars and drop grates.

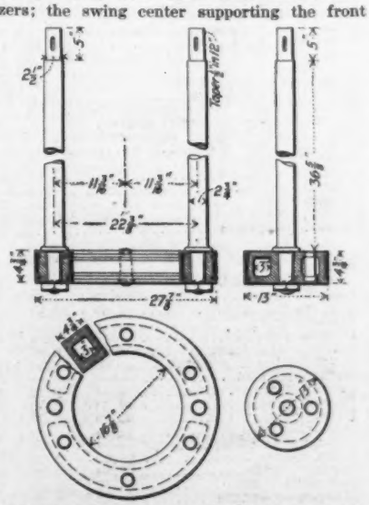
The tubes are of franklinite, swedged with copper ferules on the firebox end. They are 201 in number, 2 ins. diameter outside, No. 13 B. W. G. in thickness, 15 ft. 9 1-8 ins. long over tube sheets, and are spaced 2 3-4 ins. c. to c.

Under each boiler is a six-wheel driving truck. The truck frames are of hammered iron, made in one piece, and bolted and riveted together by wrought and cast iron plates. The pedestals are forged solid to the frames, and protected from wear of the boxes by cast iron gibs. The wheels have centers of cast iron with solid spokes and hubs and hollow rims, and turned to 42 ins. diameter to receive the tires, which are shrunk on and secured by retaining rings. The driving wheels are counterbalanced for side rods only, all reciprocating parts being balanced by the lever arrangement. The tires are to be of Midvale open hearth or Krupp steel, 48 ins. diameter, 3 ins. thick when finished. Those for the front and back pair of each set are flanged, 5 3-4 ins. wide, while those of the main driving wheels are plain, 6 1-2 ins. wide. The axles are of best hammered iron, with journals 7 1-2 ins. diameter and 10 ins. long. The driving boxes are of cast iron, with a lining of Damascus bronze. The springs are of best cast steel tempered in oil, furnished by the Charles Scott Spring Co. They are 33 ins. long, c. to c., of hangers, and have 15 plates 4x3-8 ins. and V bands. They are connected by



CYLINDER HEADS OF COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

equalizing levers. Under the smokebox is a two-wheel pony truck, with radial bars and without equalizers; the swing center supporting the front



Pistons for Compound Locomotive; Mexican Central Railway.

end of driving truck frame. The pedestals are of wrought iron, and the pedestal boxes are fitted with the Johnstone sectional brasses, and have chilled surfaces where they fit the pedestal. Each pony truck has two wrought or cast iron spoke wheels with steel tires 28 ins. diameter, secured by retaining rings. The axles are of best hammered iron, with inside journals 5 ins. diameter and 10 ins. long. There are four coil springs to each pony truck. The distance c. to c. of driving axles is 4 ft. 2 ins., the driving-wheel base of each truck being 8 ft. 4 ins., and the distance from leading driving axle to pony truck axle is 6 ft. 6 ins., c. to c.

The driving gear is of a decidedly novel type, and was designed by Mr. Johnstone, as noted in our issue of March 12, to allow of connecting the swiveling driving wheels with crossheads and cylinders rigidly attached to the main frames of the engine, instead of carrying the cylinders on the truck frames as in the Fairlie engines. To the crosshead is attached the vertical rocking lever farthest from the cylinder, and the top of this lever is connected by a coupling link to the top of the rocking lever nearest the cylinder, which latter lever is carried on journals with bearings in the main frame. To the lower end of each lever is attached a connecting rod to the main driving-wheel, the two cranks of each wheel being set at an angle of 180 degrees. The left hand crank must lead the right hand crank to give the proper motion to the valve gear. A knuckle joint in the end of the connecting rod allows of the angular sideways movement of the wheels relatively to the connecting rods when the engine is on a curve. On curves the driving power of the rods on the crank pins will not be exerted in a line parallel with the wheels, but at an angle with them, and this relation of the driving rods to the wheels will be constantly changing with the varying curves of the track. In Mr. Johnstone's original patent of 1885, referred to in our previous article, the knuckle joint in the end of the rod was put forward of the crank pin, but in the present arrangement, which has been considerably modified from that of 1885, the center line of the knuckle joint intersects that of the crank, as will be seen by the drawings of the rod details. The knuckle joint pin is 3 1-2 ins. diameter in its bearing. The weak point of the Fairlie type of engine is the flexible joint in the steam and exhaust pipes, and the part which seems most liable to prove the weak point in the Johnstone engines is the attachment of the main connecting rods to the driving-wheels.

The compounding is on the four cylinder system, each truck having four cylinders, the high-pressure cylinders, 13x24 ins., being placed inside of and concentric with the low pressure cylinders, 28x24 ins., the steam space of the latter being an annular chamber 16 3-4 and 28 ins. diameter and 5 5-8 ins. wide. The cylinders are of best close-grained iron, as hard as can be worked. The high-pressure cylinders are simply two sleeves within the low-pressure cylinders, and joints are made with the cylinder heads by 1-8 in. copper wire rings. Each low-pressure cylinder is cast in one piece, with the half saddle placed longitudinally. The right and left cylinders are reversible and interchangeable, planed and fitted, bolted together and to the smoke arch and carrying frame. The valve face and steam chest seat are raised above the face of cylinders to allow for wear. Each cylinder is lubricated by one double sight-feed Nathan lubricator, one pipe leading to the high-pressure and one to the low-pressure cylinder. The high-pressure pistons have heads of cast iron, 13 ins. diameter, 4 3-4 ins. thick, babbitted and fitted with two 1-2x1-2 in. cast iron rings turned 1-4 in. larger than cylinder and sprung in. The low-pres-

sure pistons have heads of cast steel, being rings 5 1-2 ins. wide and 4 3-4 ins. thick. They are turned 1-8 in. smaller than bore of cylinder, and bored 1-8 in. larger than the sleeve forming the high-pressure cylinder to guard against the steel coming in contact with the metal of the cylinder. The babbitted strips are turned and bored to a neat fit with the cylinders. The heads are fitted with cast iron snap rings 1-2 in. wide and 5-8 in. deep, the outside rings turned 1-2 in. larger than bore of cylinders, and the inside rings 1-4 in. smaller than outside of sleeve forming high-pressure cylinder. The piston rods are 2 3-4 ins. diameter, of hammered steel, ground and keyed to the crossheads and secured to the piston heads by nuts, the end of rod being riveted over the nut. The nuts are forged solid and chased to a close fit. There is one rod to the high-pressure piston and two to the low-pressure piston, the three rods being in the same vertical plane, spaced 11 9-16 ins. c. to c., and all connected to the same crosshead. All rods and valve stems are fitted with the United States metallic packing, according to the Mexican Central Railway standard. The crossheads are of cast steel, with cast iron gibs, babbitted. The guides are of cast iron, fitted and bolted to the cylinder head and wrought iron guide yoke.

The valve motion is of a radial type, the movement being taken from the crosshead entirely, and no links or eccentrics being used. The earlier plans provided for an adaptation of the link motion. All parts are made of hammered iron well casehardened on the wearing surfaces. The left hand crank leads the right hand, in order to give proper motion to the valves. Balance slide valves are used, with vacuum and release valves in the steam chest. The valve is formed of two sections driven by a single valve stem and yoke of usual form. The ports carrying the steam from the high-pressure to the low-pressure cylinder are formed in the cylinder heads, as shown by the details.

The main connecting rods and side rods are of I-section, 2 1-2 ins. wide, 5-8 in. thick in the web for the former and 1-2 in. for the latter. The inside and outside main rods of each pair are 5 ft. 11 7-8 ins. and 7 ft. 1 1-8 ins. long, respectively, c. to c. of bearings. The parallel or side rods are of the best hammered iron, each rod forged in one piece. The front and back ends are solid, with brass bushing, babbitted. Oil cups are forged to the rods, as shown. The main pin connection has straps and brasses, with two strips of babbitt metal in each half of the brass. The connecting rods are also of best hammered iron, forged in one piece. The front end is fitted to a block carrying solid brass bushing. The back end is forked and fitted up with straps and brasses, with two strips of babbitt metal in each half of the brass. The jaw ends of rod and trunnions on strap are casehardened and ground to a perfect fit. The straps are forged so that the grain of the iron coincides with the axis of the trunnion. All pins and the return crank are of Low Moor iron, forged so that the grain of the metal coincides with the axis of pin and crank.

The engine is equipped with a 7-in. duplex air pump of the New York Air Brake Co., and counter-pressure water brake. All the driving-wheels are equipped with the New York Air Brake Co.'s driver brakes, to work with air in connection with the train brakes. One or more main reservoirs are to be placed where found most convenient by the builders, the total capacity to be not less than 40,000 cu. ins. The water tank and coal space are located on top of each boiler, and are made of 3-16 in. and 1-4 in. iron, put together with angle iron corners, and well braced and riveted with 3-8 in rivets, 1 1-4 in. pitch. The capacity of each coal space is 2 1-2 tons, and the total capacity of tanks is 3,000 gallons. Each boiler is equipped with a Sellers No. 9 1-2 latest improved injector on the engine driver's side, and a No. 9 Friedman non-lifting injector, class W. F., on the fireman's side. The engine is furnished with two sand boxes, 33 ins. wide, placed between the frames in front of driving wheels, at each end of the engine. The valves of the sand boxes are worked from the cab. There are four sand ejectors, worked by compressed air from the main reservoir pipe. Those at either end of the engine are connected by separate 1-4-in. gas pipe from the cab, and controlled by separate 1-4-in. globe valves placed convenient to the engine driver. The pipe from globe valve to sand ejector is to be 1-2-in. diameter. The equipment of the engine includes one bell, a Crosby 6-in. single bell chime whistle, three gage cocks on each side of each boiler, two Crosby steam gages, one cab gong and two blower steam valves, the same as the Westinghouse air pump valve. There are four Ashton adjustable pop safety valves, two with perforated tops and sealed to 183 lbs. pressure, and two with muffled tops, sealed to 180 lbs. pressure. On each smokebox is placed a signal number headlight with 23-in. reflector, furnished by the Steam Gage & Lantern Co., New York. The several oil cups, cocks, plugs, check valves, etc., are of the Mexican Central Railway standard, made by the Crosby Steam Gage & Valve Co., Boston, Mass. The builders will furnish a complete set of firing tools, oil cans, etc.

All finished movable nuts and all wearing surfaces of machinery are to be made of steel or casehardened iron, except where otherwise specified. All wearing brasses are of Damascus bronze. Threads on bolts are to be U. S. standard, and studs and bolts tapped into the boiler will have 12 threads to the inch. Cylinder head casings and steam chest top are of pressed steel, painted. Low-pressure cylinders lagged with wood and cased with iron; steam chest also cased with iron and painted. The dome is lagged with wood and cased with 3-16-in. iron to protect it from the fuel carried in the coal space. The hand rail, running board and nosing are of iron, painted. The boilers are lagged with wood and jacketed with No. 22 gage sheet zinc under the water tanks and coal spaces, and the xeposed portions are jacketed with No. 13 gage Russia iron and bands of the same. The jacket extends the entire length of the cab, the joint between the boilers being covered with a wide band of Russia iron to allow for the expansion of the boilers. The cab is of iron, with double roof having an air space of 3 ins. between the roofs. It is fitted with two tool boxes on the engine driver's side, placed under the floor on which he stands. The pilots or cow-catchers are of wood, braced with iron.

The engines are to be painted black, with no striping, the paint and varnish to be rubbed to a smooth surface. The lettering is in gold, without shading. The name "Central Mexicano" will be put on the side of one tank, and the number of the engine on the same side of the other tank.

The following table gives the principal dimensions and particulars of the engines.

Gage of track	4 ft. 8 1-2 ins.
Fuel	Soft coal.
Cylinders, h.p.	13x24 ins.
Cylinders, l. p.	28x24 ins.
Steam ports; h.p., 1 1-4x14 ins.; l. p.	1 1-2x14 ins.
Exhaust ports	2 2-4x14 ins.
Distance c. to c. of cylinders	6 ft. 11 ins.
Distance c. of cylinder to valve face	1 ft. 9 1-4 ins.
Piston rods, diameter	2 3-4 ins.
Driving wheels, diameter	4 ft. 0 ins.
Truck wheels, diameter	2 ft. 4 ins.
Journals of driving axles	7 1-2x10 ins.
Journals of truck axles	5x10 ins.
Wheel base, driving (each truck)	8 ft. 4 ins.
Wheel base, total	45 ft. 10 7-8 ins.
Distance c. to c. of pony truck and first driving axle	6 ft. 6 ins.
Radius bar of pony truck	4 ft. 9 ins.
Boiler, length of barrel	15 ft. 9 1-8 ins.
Boiler, diameter inside smallest ring	4 ft. 4 ins.
Boiler, thickness of barrel plates	9-16 in.
Boiler, height from rail to center line	7 ft. 3 ins.
Boiler, diameter of dome	2 ft. 6 ins.
Working pressure	175 lbs.
Staybolts, diameter	7-8 in. and 1 in.
Staybolts, pitch	4 1-4 ins.
Firebox, form	Belpaire
Firebox, size at grate	4 ft. 8 ins.x4 ft. 8 ins.
Firebox, side plates	5-16 in.
Firebox, tube plate	1-2 in.
Firebox, crown sheet	3-8 in.
Tubes, number in each boiler	291
Tubes, diameter outside	2 ins.
Tubes, thickness	No. 13, B. W. G.
Tubes, pitch	2 3-4 ins.
Tubes, length between tube plates	15 ft. 9 1-8 ins.
Smokestack, base and top diam.	15 1-4 and 19 1-4 ins.
Smokestack, height from rail to top	13 ft. 8 7-8 ins.
Weight on driving trucks	200,000 lbs.
Weight on pony trucks	30,000 lbs.
Weight, total	230,000 lbs.
Capacity of tanks	3,000 gallons.
Capacity of coal space	5 tons

BEARING METAL ALLOYS.

The February and March numbers of the "Journal of the Franklin Institute" contain an abstract of a recent lecture before the Institute on the above subject by Dr. C. B. Dudley, Chemist of the Pennsylvania R. R., describing the researches which have been made by the mechanical department of that road to determine the most economical bearing metal for use in car and locomotive journal-boxes.

With reference to the importance of the question he states that "one large corporation uses 1,000,000 to 1,250,000 lbs. annually of bearing metal." Each bearing weighs 10 to 15 lbs., so taking 12 lbs. as the average, the weight of bearings per 8-wheel car is about 100 lbs. A rough calculation, taking the Interstate Commerce Commission's statistics of rolling stock as a basis, and Dr. Dudley's figures of 12 to 18 cts. per lb. as the cost shows about 125,000,000 lbs. of bearing metal in use on locomotives and cars in the United States, representing an investment of some $21,000,000. The loss of weight per bearing by wear will be, with a fairly good bearing, about 1 lb. for each 25,000 miles run. We reprint the substance of the lecture as follows:

The reason why alloys are used as bearings in place of wrought-iron, cast-iron or steel, is partly because wear and friction are believed to be more rapid when two metals of the same kind work together, partly because the soft metals are more easily worked and got into proper shape, and partly because it is desirable to use a soft metal which will take the wear rather than a hard metal, which will wear the journal more rapidly.

A good bearing metal must have five characteristics: (1) It must be strong enough to carry the load without distortion. Pressures on car journals are frequently as high as 350 to 400 lbs. per sq. in. Moreover, it is common practice to put a new bearing on a worn journal of smaller radius than the bearing The tendency then is to concentrate the pressure on a small part of the bearing and also bring a bending strain upon it. The fact that bearings are generally lined with lead 1-8 in. thick helps to distribute the load and facilitate the fitting together of the new bearing and worn journal.

(2.) A good bearing metal should not heat readily. The old copper-tin bearing, made of seven parts copper to one part tin, is more apt to heat than some other alloys. In general, research seems to show that the harder the bearing metal, the more likely it is to heat.

(3.) Good bearing metal should work well in the foundry. Oxidation while melting causes spongy castings. It can be prevented by a liberal use of powdered charcoal while melting; but in a foundry rushed with work, sufficient care cannot always be taken, hence a metal which gives least trouble in the foundry is preferable. The addition of one per cent. to two per cent. of zinc or a small amount of phosphorus greatly aids in the production of sound castings. This is a principal element of value in the well-known alloy, phosphor-bronze.

(4.) Good bearing metals should show small friction. It is, indeed, true that friction is almost wholly a question of the lubricant used; but on the other

Analyses of Bearing Metal Alloys.

Metal.	Copper.	Tin.	Lead.	Zinc.	Antimony.	Iron	Other constituents.
Camelia metal	70.20	4.25	14.75	10.20	——	0.55	
Anti-friction metal	1.60	98.13	——	——	——	trace	
White metal	——	——	87.92	——	12.08	——	
Car-brass lining	——	trace	84.87	——	15.10	——	
Salgee anti-friction	4.01	9.91	1.15	85.57	——	——	
Graphite bearing metal	——	14.38	67.73	——	16.73	?	no graphite.
Antimonial lead	——	——	80.69	——	18.83	——	
Carbon bronze	75.47	9.72	14.57	——	——	——	possible trace of carbon.
Cornish bronze	77.83	9.60	12.40	trace	——	trace	trace of phos.
Delta metal	92.39	2.37	5.10	——	——	0.07	
Magnolia metal	trace	——	83.55	trace	16.45	trace	possible trace of bismuth.
American anti-friction metal	——	——	78.44	0.98	19.60	0.65	
Tobin bronze	59.00	2.16	0.31	38.40	——	0.11	
Graney bronze	75.80	9.20	15.06	——	——	——	
Damascus bronze	76.41	10.60	12.52	——	——	——	
Manganese bronze	90.52	9.58	——	——	——	——	no manganese.
Ajax metal	81.24	10.98	7.27	——	——	——	phos. or arsenic 0.37.
Anti-friction metal	——	——	88.32	——	11.93	——	
Harrington bronze	55.73	0.97	——	42.67	——	0.68	
Car-box metal	——	——	84.33	trace	14.38	0.61	
Hard lead	——	——	94.40	——	6.03	——	
Phosphor-bronze	79.17	10.22	9.61	——	——	——	phos., 0.94.
Ex. B. metal	76.80	8.00	15.00	——	——	——	phos., 0.20.

hand, the metal of the bearing has certainly some influence. Further experiments are greatly to be desired.

(5.) Other things being equal, the best bearing metal is that which wears slowest.

The principal constituents of bearing metal alloys are copper, tin, lead, zinc, antimony, iron and aluminum. We condense the details given as to the chemical composition of the alloys tested in the following table, which gives the constituents of most of the prominent bearing metals as analyzed at the Pennsylvania Railroad laboratory at Altoona.

The above analyses represent metals offered by many different parties. In some cases, where very small amounts of other metals than those named were present, they were not determined. Sometimes these may fairly be regarded as impurities. In other cases they may be essential constituents, and this is indeed claimed for one or two. Whether these small amounts of other constituents are of value or not, our experiments have not yet gone far enough to prove. As an example of the influence of minute changes in an alloy the Harrington bronze, which consists of a minute proportion of iron in a copper-zinc alloy, showed after rolling a tensile strength of 75,000 lbs. and 20 per cent. elongation in 2 ins.

Because of the immense number of possible combinations of metal in alloys, and the great influence of slight changes of composition, the determination of the best bearing metal is a difficult matter. Even now some railways and some machine builders still use for bearing metal the old cannon bronze, made of seven parts copper to one of tin, although experiments have proved other alloys to be much superior.

In experimenting on this subject on the Pennsylvania Railroad, a certain number of the bearings were made of a standard bearing metal, and the same number were made of the metal to be tested. These bearings were placed on opposite ends of the same axle, either on locomotive tenders or on cars, one side of the car having the standard bearings, the other the experimental. Before going into service the bearings were carefully weighed, and after a sufficient time they were again weighed. At first it was attempted to give the loss of the metal with reference to mileage, but this introduced so many uncertainties that it was abandoned.

The standard bearing metal used is the "S bearing metal" of the Phosphor-Bronze Smelting Co. It contains about 79.70 per cent. copper, 9.50 per cent. lead, 10 per cent. tin, and 0.80 per cent. phosphorus. It is, of course, a fair question whether this metal gives uniform wear. A large number of experiments have shown that the loss of weight of a bearing of this metal is 1 lb. to each 18,000 to 25,000 miles traveled. This variation led us to abandon the method of comparisons by mileage. But the variable conditions of service, such as variation in pressure per sq. in. on the journal and variable lubrication, are sufficient to explain the above variation in wear. It will be noted that within reasonable limits the unit pressures on opposite ends of the same axis will be the same and the state of lubrication is not likely to vary much.

It was believed, therefore, that the standard bearing metal is sufficiently uniform in its behavior to warrant its being used in the experiments, especially as the comparison was confined to the wear of bearings on opposite ends of the same axle and the average of a large number is taken as the result. Usually 16 bearings of each kind were put in service on locomotive tenders as a preliminary experiment, and if the results proved at all favorable, 50 or 100 bearings were put in service, usually on cars. In weighing the bearings for determining the results, when a bearing was missing, its opposite was not taken into account, so the comparisons are strictly between the wear of an equal number of standard and experimental bearings on opposite ends of the same axles. Besides the measurement of wear, observations were made on the frequency of "hot boxes" with the different metals.

The results of the tests for wear, so far as given, we condense into the following table, in order to facilitate comparison:

Metal.	Composition. Copper.	Tin.	Lead.	Phos.	Arsenic.	Rate of wear.
Standard	79.70	10.00	9.50	0.80	——	100
Copper tin	87.50	12.50	——	——	——	148
Copper tin, second experiment, same metal.....						153
Copper tin, third experiment, same metal.....						147
Arsenic-bronze ..	89.20	10.00	——	——	0.80	142
Arsenic-bronze ..	79.20	10.00	7.00	——	0.80	115
Arsenic-bronze ..	79.70	10.00	9.50	——	0.80	101
"K" bronze....	77.00	10.50	12.50	——	——	92
"K" bronze, second experiment, same metal....						92.7
Alloy "B".....	77.00	8.00	15.00	——	——	86.5

The old copper-tin alloy of 7 to 1 composition is seen to have repeatedly proved its inferiority to the phosphor-bronze metal. The tests were made on some hundred bearings of each kind and many more of the copper-tin bearings heated than of the phosphor bronze. The showing of these tests was so satisfactory that phosphor-bronze was adopted as the standard bearing metal of the Pennsylvania R. R., and was used for a long time.

The experiments, however, were continued. It has been found that arsenic practically takes the place of phosphorus in a copper-tin alloy, and three tests were made with arsenic bronzes as noted above. It has been before hinted that the phosphorus in the metal was chiefly valuable in the foundry, and the results of these experiments seemed to show that arsenic did not materially affect the wearing qualities of the alloy. Notice that as the proportion of lead is increased to correspond with the standard, the durability increases as well. In view of these results the "K" bronze was tried in which neither phosphorus nor arsenic were used, and in which the lead was increased above the proportion in the standard phosphor-bronze. The result was that the metal wore 7.30 per cent. slower than the phosphor-bronze. No trouble from heating was experienced with the "K" bronze more than with the standard. Dr. Dudley continues:

At about this time we began to find evidences that wear of bearing metal alloys varied in accordance with the following law: "That alloy which has the greatest power of distortion without rupture (resilience), will best resist wear." It was now attempted to design an alloy in accordance with this law, taking first the proportions of copper and tin, 9 1-2 parts copper to 1 of tin was settled on by experiment as the standard, although some evidence since that time tends to show that 12 or possibly 15, parts copper to 1 of tin might have been better. The influence of lead on this copper-tin alloy seems to be much the same as a still further diminution of tin. However the tendency of the metal to yield under pressure increases as the amount of tin is diminished, and the amount of the lead increased, so a limit is set to the use of lead. A certain amount of tin is also necessary to keep the lead alloyed with the copper.

After considerable preliminary work, bearings were cast of the metal noted in the table as Alloy "B," and it will be seen in the tests that it wore 13.5 per cent. slower than the standard phosphor-bronze. This metal is now the standard bearing metal of the Pennsylvania Railroad, being slightly changed in composition to allow the use of phosphor-bronze scrap. The formula adopted is: Copper, 105 lbs.; phosphor-bronze, 60 lbs.; tin, 9 3-4 lbs.; lead, 25 1-4 lbs. By using ordinary care in the foundry, keeping the metal well covered with charcoal during the melting, no trouble is found in casting good bearings with this metal. The copper and the phosphor-bronze can be put in the pot before putting it in the melting hole. The tin and lead should be added after the pot is taken from the fire.

It is, of course, not known whether the use of a little zinc, or possibly some other combination, might not give still better results. For the present, however, this alloy is considered to fulfill the various conditions required for good bearing metal better than any other alloy.

Dr. Dudley closed with some discussion of the properties of metal which most affect its resistance to wear. Comparing the standard phosphor-bronze and the "B Alloy," he found that the phosphor-bronze had an ultimate tensile strength of 30,000 lbs., with 6 per cent. elongation, whereas the Alloy "B" had 24,000 lbs. tensile strength and 11 per cent. elongation.

Leaving out of account the various conditions of lubrication, pressure, speed and temperature, he concludes from all the data he has collected: (1) That the metal which suffers greatest distortion without rupture will wear slowest. (2) That with a given elongation the resistance to wear increases with increase in tensile strength. (3) That the finer the granular structure of the metal, the slower will be the wear. As evidence bearing on (2), he says that car axles are made of metal two or three times as strong as the bearing metal and lose about 1 lb. in 75,000 miles, whereas the bearing loses 1 lb. in 25,000 miles. Some evidence as to (3) is afforded by the fact that case-hardened iron wears better than either wrought iron or hammered steel of approximately the same carbon. Dr. Dudley thinks it not improbable that the granular structure is the most important factor in determining the rate of wear.

GAGINGS OF HOURLY SEWAGE FLOW AT SCHENECTADY, N. Y.

The city of Schenectady has about eighteen miles of sewers, fifteen of which discharge through one outlet. Into this outlet 1,500 connections discharge, nearly all of which are house connections. Mr. William B. Landreth, C. E., made hourly gagings of the flow of this outlet during the 24 hours from 9 a. m., Feb. 5, to 9 a. m., Feb. 6. The flow during that period is shown by the accompanying diagram and by the table below.

Gagings of Flow from 18-in. Outlet Sewer, Schenectady, N. Y., from 9 a. m., Feb. 5, to 9 a. m. Feb 6.; Wm. B. Landreth, City Engineer.

At the time the gagings were made no roof water was flowing into the sewers, but 50,000 gallons were being discharged into it each 24 hours from flush tanks and 60,000 gallons by seepage, the latter having been determined before the connections were made.

The hourly flow and percentage of the same to the total flow was as follows:

Feb. 5.	Hourly flow.	Percentage of total flow	Feb. 5.	Hourly flow.	Percentage of total flow
9 a. m...	39,800	4.63	10 p. m...	33,884	3.94
10 a. m...	43,352	5.04	11 p. m...	33,884	3.94
11 a. m...	37,475	4.36	12 midn't..	32,718	3.80
12 noon...	37,475	4.36	Feb. 6 .		
1 p. m...	38,632	4.49	1 a. m...	32,718	3.80
2 p. m...	39,800	4.63	2 a. m...	32,718	3.80
3 p. m...	41,073	4.78	3 a. m...	30,294	3.52
4 p. m...	38,632	4.49	4 a. m...	32,718	3.80
5 p. m...	37,475	4.36	5 a. m...	31,416	3.65
6 p. m...	36,423	4.23	6 a. m...	31,416	3.65
7 p. m...	36,423	4.23	7 a. m...	34,044	4.00
8 p. m...	36,423	4.23	8 a. m...	36,423	4.23
9 p. m...	33,884	3.94			

It will be seen that the greatest flows were at 10 a. m. and at 3 p. m., when 5.04 per cent. and 4.78 per cent., respectively, of the total daily flow of about 860,000 gallons passing through the sewer. We are indebted to Mr. Landreth for the above information.

The Magdalena & Cartagena Railway, in the United States of Colombia, is expected to be constructed this year. The Chief Engineer, Mr. W. D. Buckner, sailed from New York for Cartagena, March 17, on the "Alvo," with a party of engineers, rodmen and chainmen. The road will be built by the Cartagena Terminal & Improvement Co., of Boston, whose project includes wharves and warehouses at the port of Cartagena, and a railway thence to a point on the Magdalena river. This river is navigable for 630 miles, but the mouth is impassable owing to the shifting sand bars. The works were reported on by the late Col. S. H. Lockett, and were briefly noted in our issue of May 9,1891. An order for 4,500 tons of 45-lb. steel rails has been placed in England at $20 per ton on board steamer at Liverpool. Mr. J. Murray Forbes is President of the company.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING.*

XV.

THE COMPARATIVE SAFETY OF VARIOUS CAR-LIGHTING PLANTS.

Safety and danger are relative terms. In a literal sense there is hardly a known substance or process so safe as not to be at times dangerous, or so dangerous as not to be at times safe. A carpet is by general admission a tolerably safe and harmless article for general use; yet it has been put on record that in France there were 14 persons who suffered death in staying at home and there tripping over carpets to 10 killed in railway accidents.†

On the other hand, dynamite is by general admission a highly dangerous substance for general use; yet it is on record that when it was first introduced it was claimed to be as safe and harmless as corn meal or sugar to handle or to transport, except when in the presence of exploders. Elaborate experiments were made tending to show this, and which in a sense did show it, in order to persuade the railways that no restrictions were needed on its transportation. It was thrown in large quantities on bonfires, and burned harmlessly. Boxes of it were thrown from the top of the Palisades, falling some 200 or 300 ft., and stones then thrown down upon them. It was placed upon wooden floors and pounded, and small quantities were even placed upon iron and struck with a hammer to show that though small detonations would occur under the hammer, they were not of sufficient force to explode the rest of the mass lying alongside. These tests were also made with frozen dynamite, and considerable quantities were frozen and thawed repeatedly to show that there was "no danger" in that.

As a consequence, many of the railways were convinced, and transportation at low rates (for dynamite) was granted. It was but a very short time thereafter before a series of frightful disasters began to demonstrate the inconclusiveness of these experiments. Some of these accidents occurred under circumstances which differed from the prior tests only in result—some of them from causes or circumstances which had not been anticipated. The privileges previously granted were speedily withdrawn and have not been renewed to this day. No railway engaged in general traffic will now transport dynamite on any terms, if it knows it.

This record as to dynamite illustrates one truth which it is important to keep in mind. Laboratory tests of all kinds which attempt to prove that any substance or process otherwise open to suspicion is "not dangerous" have that fatal element of inconclusiveness about them which attends all efforts to prove a negative. What they set out to prove, and have often been too carelessly assumed to prove, is that such substance or process is under no circumstances dangerous, or unreasonably or exceptionally so. What they actually do prove is merely that under the specific conditions tried, and in the specific hands which tried them, they are or are not thus dangerous. The distinction is a broad one.

Nevertheless, though every process is at times safe, and each is at times dangerous, we are all conscious that there is a foundation of truth in the popular practice of roughly dividing all substances and processes into two great classes, "safe" and "dangerous," according as there is a preponderating tendency to safety or danger. We take it that the distinction is a just one, analogous to that which is drawn in mechanics between stable and unstable equilibrium. A substance poised so that the application of any extraneous force, or the removal of any of the props which support it will topple it over, is in "unstable" or *dangerous* equilibrium. A substance which can only be disturbed by the application of some extraneous force, and which when that force ceases returns to its original position, is in "stable" or *safe* equilibrium.

As another illustration, all horses are at times controllable or "safe"; all horses may at times run away or become "dangerous." But the horse which runs away only from some specially startling cause, and tends to quiet down again when that cause is removed, is a "safe" horse; the horse which is only manageable under the watchful care of a good driver, and when he does run away becomes more and more excited and uncontrollable, is a "dangerous" horse. The livery-stable keeper who has to turn his horses over to the tender mercies of all sorts of drivers prefers the "safe" horse every time; though for his own use he may choose the "dangerous" one as good enough for him and quite safe in his hands.

The three illuminants used by the three different systems of car lighting which are alone now prominent are: (1) Mineral sperm oil of 300° F. fire test; (2) a fixed gas; and (3) the lightest form of gasoline, of 88° Beaumé, which it is emphatically asserted in all instructions for using the plant must not be any heavier, but which may be and often is lighter, running down often if not frequently [Eng. News, May 23, 1891, p. 492] to 91° B. gasoline, which boils at 82° F. under 3 lbs. pressure.

Measuring these three substances by the standard we have endeavored to define, and considering them only as substances, apart from the plant used for burning them, it will not be disputed that the first two, heavy oil and a fixed gas, are justly definable as "safe" substances. Long experience has shown that they may be used by millions of ordinary men with no more than the usual and instinctive care which the millions give, with such an approach to impunity as to make accidents the rare exception.

By the same standard, gasoline of all gravities, and especially the light 88° to 91° gasoline, is a "dangerous" substance, one of the most subtle and elusive combustibles and explosives known to man. It does not follow that it should not be used. It does not follow that its use may not be made safe and justifiable. Steam itself, man's best and (as yet) sole efficient servitor for power, is a substance of like nature, though in much less degree.

But if the use of gasoline be made safe, it can only be the "unstable" kind of safety, from the nature of the substance. It may be perfect while the props and balances which maintain it are perfect, but it is liable to "slop over" into danger if any one of these props fail. There is a presumption against the general use of gasoline as a car illuminant, therefore, which does not exist against the use of either one of the other illuminants. The burden of proof is not upon him who suspects it to be dangerous; it is upon him who asserts it to be safe. He is not doing justice to himself or to the public who does not assume and maintain toward the use of such an illuminant for car lighting a mental attitude of keen, unyielding skepticism until it is proved beyond a shadow of doubt that (1) there are material advantages to be gained by its use, and (2) that the plant in which it is used is so perfect in design and function that it involves no liability of "slopping over" into danger in unexpected ways. For it is to be remembered that the case is not as with steam, where the choice lies between using steam and going without power. If there were two or three other means of developing power, by which as many horse power could be obtained at equal or less cost, the question of whether or not the risks attending the use of steam boilers were expedient or justifiable would assume a very different aspect from what it has now. With steam we have no rational choice; with car lighting we have.

We now proceed to consider what theory and experience indicate in regard to the safety of the several plants as actually constructed and used, beginning with the compressed gas system, the only form of which now before the public is the so-called Pintsch gas plant.

THE COMPARATIVE SAFETY OF THE PINTSCH OIL GAS PLANT.

The manufacture of the gas is essentially similar in its processes to the manufacture of coal gas, which has been carried on for over half a century* in every considerable town of the civilized world, with so few accidents as to make it one of the safest of processes. Occasionally small accidents occur, gasometers are struck by lightning, pipes leak into a parallel conduit filled with air, and an explosive mixture is formed; but the exceptions merely prove the rule.

Experience and analogy seem to indicate that the same is true in substance of the Pintsch gas making plant.* We have been able to obtain record of only two accidents to any of these plants, about 175 of which are now in operation. A somewhat similar plant, known as the Foster plant, but with important differences of construction and arrangement, had two explosions, one at Ludlow, Ky., July 15, 1888, by which over 15 persons were injured, and one at Reading, Pa., March 3, 1890, by which several persons had "narrow escapes." The first accident was caused by an escape of liquid naphtha (which the now defunct Foster company used instead of crude petroleum to make gas from) from a pipe connection with the naphtha reservoir,† which caused the naphtha reservoir to explode; the other‡ was also an explosion caused by a fire, and apparently of the same nature. The gas tanks did not explode, though the building was completely destroyed, and it was expected that they would. In both of these instances, the only serious accidents to "oil gas" plants of which we have record, inexperience and faults of construction may reasonably be regarded as the cause of the accident, and as peculiar to the now defunct Foster plant. There was also an explosion which blew out a window of the Pintsch gas works at Mott Haven, N. Y., Nov. 15, 1889. It did not destroy the storage tanks, nor do any injury of moment to the plant, the company informs us, and originated from a leak in a retort in the gasworks. A similar but slighter explosion, due to causes explained in a letter from General Superintendent Olhausen, reprinted below, occurred March 16, 1891, at the gasworks of the Central Railroad of New Jersey, in Jersey City. The doors and windows were blown out, and two men were quite badly burned.

Doubtless other incidents like that at Mott Haven and Jersey City have occurred elsewhere with Pintsch gas, as they do at rare intervals with ordinary coal gas, but they appear to us to be so few and unimportant as to leave the process of manufacture as safe as ordinary gasmaking.

The process of charging may cause accident by moving the car while the hose is coupled on, causing rupture of the hose and escape of gas, which is ignited. The company admits three instances of the kind (i.e., of the rupture) within eight years. There are but two records known to us of consequent accident to person or buildings from this cause. Doubtless there have been other like cases. In one case last fall, at the Grand Central Station in New York, a man was burned and a car set on fire and destroyed, by escape of gas due either to rupture of a hose or carelessness in coupling. The Pennsylvania R. R. has been charging tanks with coal gas in this way, while cars were stopping at stations, since it introduced gas lighting in 1872, 20 years ago. No instance of such rupture by careless neglect to uncouple was recalled by its officers a year ago, but about six months ago one did occur to a night express at Harrisburg, for, due to the moving of a train by a shifting engine while a car was charging, the escaping jet from the charging pipe was shut off at once, but the escape from the car tank was set on fire by the car-fitters' torch while attempting to extinguish it, and he was burned by the flames.

Not a single instance is on record of a car gas tank (or storage gas tank) exploding, either as an effect of heat or concussion. The possibility of exploding a car tank by concussion was made the subject of tests by Mr. G. M. Hunter,§ with the result that blows of a weight of 400 lbs. falling 15 ft. on a 16-in. recipient heated by fire, failed to cause any explosion even when a puncturing appliance was added. In a number of cases broken car wheel tires have punctured tanks, letting the gas escape with-

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* Erratum. In the first footnote of the middle column of page 256 of our last issue, reference is made to "a following table," which does not appear in the note. The table which should have followed as a part of the note was, by error in the make up, left in the middle of the column above, immediately below a little table which does belong there, where it is obviously superfluous.

A reference list to the prior articles of this series, beginning with our issue of April 18, 1891, was given in our last issue, p. 370.

† "Railroad Accidents," by Chas. Francis Adams, p. 242.

* The use of artificial gas was one of Mr. Wm. Murdock's inventions, and was used for lighting the shops of Boulton & Watt, in 1798. Its use became general in London, where the first works were erected in 1816.

* The company claim that the Pintsch gas-making process is safer than that for ordinary coal gas, and advance some plausible reasons therefor, which it has not seemed feasible to investigate with sufficient care to express a positive opinion on them.

† See "Cincinnati Inquirer," July 15, 1888, for details.

‡ See Philadelphia "Evening Telegraph," March 3, 1890, for details.

§ Eng. News, April 13, 1889; Trans. Inst. C. E., vol. xcv., p. 224.

out injury. Out of a number of collisions affecting cars supplied with gas tanks, there was a "most disastrous" one on the Seacombe, Hoylake & Deeside line, in England,* the carriages being "considerably knocked about." One train had the lamps lighted, and the other not. "No accident of any sort happened with regard to the lighting." The Pintsch tank is exceedingly well constructed, with welded joints throughout, tinned inside and out, and tested to 300 lbs. pressure. Should a tank ever by any chance give way under its maximum pressure of about 150 lbs. we need not explain to our readers that no explosion could occur, as with a steam boiler under that pressure, there being no "magazine of explosive energy" to cause it to do so, like the heat stored in the water of a boiler. The tank would merely rip open enough to relieve the pressure.

There have been one or more mistaken newspaper reports, however, of "gas tanks exploding while being filled." One such (the only one we know of) resulted from a gas explosion in a car, which occurred at Jersey City, Feb. 12, 1891. In the "Evening Journal" and "World" of the next day, it was stated that the head of the gas tank blew out and was driven through the adjoining car. These reports were reprinted and sent about by circular, of which we received a copy. We immediately addressed a letter of inquiry to General Supt. J. H. Olhausen, and received from him the following reply:

Sir: Answering your letter of 15th inst. I would state that the articles published in the "Evening Journal" and the "World" regarding gas explosion at Jersey City on Feb. 13 are erroneous. There was no explosion of the cylinder or tank. The facts are that an obstruction was noticed in the gas pipes of parlor car "Dahlia" and our men thought they could remove this obstruction by blowing gas through the pipes under heavy pressure. Unfortunately for them, the car was closed tightly (both ventilators and windows) and they never thought about opening these when gas was blown in the car. They went into the car afterward to shut off the different burners, and while doing this the explosion took place. It is presumed that the gas ignited from either a lighted cigar or pipe; it may possibly have caught from the fire in the Baker heater. Under similar circumstances any gas, if good, would have exploded. The explosions caused no damage whatever to the gas attachments of the car; the only damage done was the breaking of car windows and disarrangement of curtains and some woodwork.

The other accident referred to in circular [the explosion at the gas works at Jersey City, March 16, 1891, above noted] is explained as follows: One of the pipes in the gas house stopped up, and in some way the oil seal on the outside became loosened and blew out. Some of the oil caught fire and communicated to a small supply tank. The loss in this case amounted to very little, and we have rearranged the pipes in a way which will render it almost impossible for another accident of this kind to occur. [Arrangement described in Eng. News, Aug. 29, 1891.]

By using ordinary care I see no reason why the Pintsch gas is not as safe as any other system of car lighting. If I had not thought it was perfectly safe, we certainly should not have adopted the system on this road.

Yours truly, J. H. Olhausen, General Supt.

Jersey City, N. J., April 16, 1891.

There is at least one instance on record where the puncturing of a tank caused a very serious disaster by ignition of the gas, at Wannsee, Germany, on the Berlin & Potsdam Railway, in 1887. A passenger and freight train collided, perforating the gas tank under a second class carriage. The escaping gas was in some way ignited and several passengers (all those in one compartment, we infer) were burned to death before they could escape. We have learned of no other such accident to a Pintsch tank, but one of somewhat similar nature happened to one of the Pennsylvania coal gas tanks at Thompsontown, Pa., soon after coal gas lighting was adopted, or late in the '60's. The gas cylinder was then in the closet, the pipes became disarranged, the whole contents of the tank were discharged into the car and caught fire from the car stove, and nine passengers lost their lives. The fault here of course was placing the tank inside the car. There was also another case some years later on the Pennsylvania R. R., when a car with a gas tank under it turned over on its side in a cut, rupturing the tank or connections, and letting a stream of gas escape which in some way was ignited, burning a passenger and the side of the car somewhat. There was also a case on the Alton last year where a glancing side collision with a locomotive ruptured a pipe, the gas taking fire from the firebox and burning the outside of the car some. what.

We have also learned, in the process of our inquiries, of a case where an oxygen gas tank of about the size of a Pintsch receiver exploded in England some 22 years ago, with consequences not on record. Such an instance is hardly pertinent, since the presumption is that the construction of the tank was faulty.

An escaping jet of any gas under high pressure is exceedingly difficult to ignite. To light freely a pressure of only an ounce or so is desirable. Recent experiments in Ohio have shown this as to the Pintsch gas. The present writer found it to be true of an escaping jet of natural gas, which it was impossible to ignite with a match held in any position, though under low pressure it was as readily ignited as any gas. Of course the high pressure is by no means an infallible protection against ignition, but it is some protection.

There was a serious accident near Paris, July 29, 1891 (C. de F. de l'Est) where it was reported in the daily press that "A gas tank had exploded and caused fire." This report was unfounded. A copy of the official report on the accident has been furnished us, from which it appears that the gas plant had nothing to do either with the causes or effects of the disaster. A tank engine without tender was derailed, and two cars behind crushed upon it and took fire from the firebox. The gas plant was intact throughout after the disaster, though a leak had been started through which the gas escaped.

One of the most frequent causes of accident from city gas is its escape into a closed chamber, forming an explosive mixture with the confined air. Should gas escape from a Pintsch burner, however, it escapes into a closed chamber, having direct and free communication with the outside air, and the gas being lighter than air, unlike carbureter gas, it tends to rise and escape at once. Hence, if there be escape from the burners, gas cannot remain about the lamps to cause trouble when the globe is lowered to light it. Nor is the gas likely to accumulate within the car to any dangerous extent if the globe be broken and the flames extinguished by some accident. Such an accident either will or will not crush in the upper works of the car. If it does, the gas readily escapes, since it rises in air. If it does not, then the passengers have room and opportunity to escape. The rate of combustion (12¼ to 13¾ cu. ft. per hour per car) is so slow that a car would have to be hermetically sealed for some little time to make it dangerous to confined passengers. No instances of trouble from explosive or asphyxiating mixtures are on record to our knowledge, under ordinary conditions, or under any conditions except as detailed above.

This system was introduced in Germany in 1871, and into England in 1876. It has since been in large and increasing use, being now used on about 38,000 cars and (in Germany) on nearly 1,000 locomotives. In view of this record of service with so trifling a record of accident, experience would seem to have established that it is an eminently safe system; approaching as nearly to perfect safety under all conditions as it is reasonable to expect from any system using a flame as the source of light, not to say from any system of any kind. "A priori" reasoning, from the fact that it is difficult to put one's finger on a single feature of the system which one might expect to prove a source of danger, except under some rare combination of unfavorable circumstances, leads to the same conclusion, independently of the records of experience.

A strong feature of the plant is that it is free from the danger of secret degradation of the quality of the illuminant, in order to make larger profit from a cheaper article, which has proved to be one of the most serious dangers with oil lamps. The comparative safety of this latter system of lighting we will now consider.

* Trans. Inst. C. E., vol. xc. iii.; paper by Arthur Ayres, p. 45.

Cablegrams can be sent from Europe to Buenos Ayres in 30 minutes, says "Engineering," by way of Galveston and Valparaiso, and thence by the Transandine Telegraph Agency, now working with the Central & South American Telegraph Co.

CORRIDOR CARS FOR THE GREAT WESTERN RAILWAY, ENGLAND.

A train made up of "corridor" cars has recently been put in service by the Great Western Railway, of England, and is of interest as indicating the tendency toward American practice in such matters, and away from the old, and still generally used, type of compartment car of English railways, in which passengers are practically imprisoned during their journey. The privacy of the compartment system is, however, retained, as in some recent types of American cars. The arrangement of each car includes several compartments, with a corridor running along one side, from end to end, this arrangement being similar to that of the Great Northern Railway third-class saloon car illustrated in our issue of Feb. 7, 1891. The cars for the "Corridor Train," as it is called, were designed by Mr. William Dean, Locomotive Superintendent of the Great Western Railway, and were built at the company's car works at Swindon. The train runs between London and Birkenhead, a distance of 228 miles.

The train consists of four passenger cars, each 50 ft. long and 9 ft. wide and a conductor's and baggage car 40 ft. long and 8 ft. wide. There is one first-class, one second-class and one third-class car, each having three ordinary compartments, a smoking compartment, double the size of the ordinary, a women's compartment, and a lavatory at each end. The fourth passenger car is third-class, with conductor's and baggage compartment. Each of the ordinary compartments of the first and second-class cars seat four persons only, giving ample space, and the smoking compartment has a middle gangway between the seats. Along one side of the car is a corridor, with a door to each compartment and corresponding doors in the side of the car, each compartment having also a door in the side of the car opposite to the corridor. At the doors the width of the corridor is slightly increased by bulging out the side of the car. A narrow covered gangway or vestibuled connection is made between the corridors of the cars, but this is only for the use of the conductor, the passengers keeping to the car of their own class. The first-class car is finished in oak and upholstered in blue cloth, the second and third-class cars are upholstered in rep and all the smoking rooms are upholstered in leather. The finish and interior fittings and decoration are said to be unusually elaborate, and the decorations include large photographs of scenery along the line.

The cars are of standard gage, and are carried on trucks or "bogies." They have monitor roofs, are lighted by the Pintsch compressed gas system, and heated by steam from the locomotive. In each compartment is an electric call to summon the conductor, an annunciator indicating from which compartment the signal is given. Along the cornice of the roof where the communication cord to the conductor and engine driver is generally placed, is a rod connected with a valve in the train pipe of the vacuum automatic brake, and by means of a handle in the car the passengers can apply the brakes in case of emergency. Should this be liable to stop the train at a dangerous place, the engine driver can keep the brake partly off by means of the brake ejector, enabling him to proceed for some distance at reduced speed, but the conductor would at once proceed to the compartment where the emergency application had been made, this being indicated by a disk signal. This arrangement is in use on the Manchester, Sheffield & Lincolnshire Railway (Eng. News, Dec. 6, 1890). The Great Western Railway and its ordinary rolling stock have been described in our issues of Feb. 21 and 28, 1891.

The Birmingham Central Tramway Co., of England, in the director's report for 1891, gives the working expenses per car of the four different systems of traction in use by this company, as follows:

Steam, working cost per car mile	21.98 cts.
Horses, " " " " "	19.58 "
Cable, " " " " "	12.66 "
Electricity " " " " "	19.80 "

Comparing this with the returns of the West End Co., of Boston, Mass., for July, 1891, and remembering that labor costs more in America than in England, we have:

Horses, working cost per car mile	24.12 cts.
Electricity, " " " "	20.28 "

THE BALTIC AND NORTH SEA CANAL.

In our issue of Aug. 1, last, we gave an illustrated description of the Baltic and North Sea Canal, showing chiefly the method of constructing the embankments. From "Le Genie Civil," of Nov. 7, we abstract the following further details of this interesting work:

This canal, which is intended to connect the Baltic and the North Seas, commences near Holtenau, on the Baltic, and terminates at Brunsbuettel, on the North Sea, where the estuary of the Elbe provides a useful least depth of 29 1-2 ft. At each end there will be a double lock with safety gates. The lock-gates will be opened or closed according to the varying level of the inside and outside the canal, and when this difference of level exceeds 20 ins. Between the ends the canal maintains a single level traversing the Marschland of Holstein.

From the Baltic entrance to kilo. 22 the work was of little importance. The soil is in part below the canal level and here dikes are necessary. At Gruenthal the bed of the canal will be 108.24 ft. below the ground level, and the line of the canal cuts the crest of the divide (82 ft. above sea level) separating the valleys of the Elbe and the Eider. The soil is generally sand, and in the deeper beds is a moving or quick sand. There are also beds of peat underlaid in places by clay.

As to the trace of the canal the plan given shows light curves, the minimum radius being 1,000 m., or 3,280 ft., with other curves of 3,000 m. radius. In cases of reverse curves there is a straight connecting line not less than 830 ft. long, or double the length of the longest ship which is to navigate the canal. The sum of all the angles that the ships will have to pass is 841 degrees, and the angle of entrance, with the current of the Elbe, is 133 degrees. The profile given shows that the level of the single reach of the canal between the termini coincides with the mean level of the Baltic.

As the canal will usually be navigated with open locks, it is evident that for the greater part of the year the water will flow into the canal from the Baltic side. But at the Elbe terminal the locks will be open only during 3 or 4 hours in the day, at high tide, and during this time from 3 to 4 million cu. m. of water will flow from the canal, which would wash away any sand from the entrance channels. In about the same time 370,000 cu. m. of fresh water would enter the canal. This current of pure Baltic water towards the Elbe will facilitate the operation of the canal, by taking away any mud which might enter from the Elbe. The prevailing winds, however, have a bad effect, as they tend to raise the level of the Elbe and lower the Baltic level, thus allowing the Elbe water to enter the canal.

The line of the canal crosses at several points courses of fresh water, at their level, and where these streams are higher the beds are lowered to meet the new conditions. Figs. 1 and 5 show the levels of the two seas as compared with the canal proper. The depth of the canal is 25.4 ft. or the maximum of ships of war.

Fig. 1. Plan of Baltic and North Sea Canal.

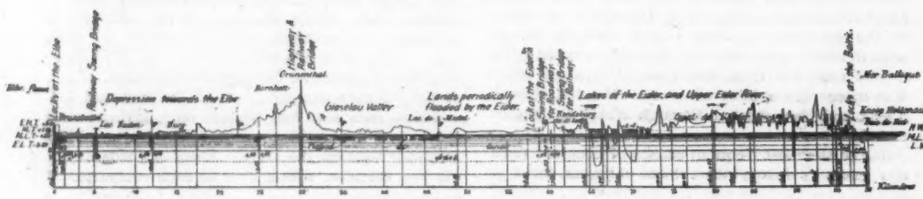

Fig. 2. Profile.

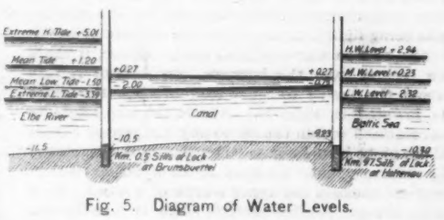

Fig. 5. Diagram of Water Levels.

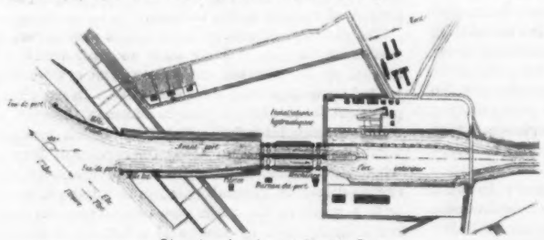

Fig. 3. Locks at North Sea.

The transverse section of the canal is established after the following conditions: (1) The profile of the canal, when the water is lowest, presents a surface equal to six times the wet surface of ships of commerce of 60 to 62 cu. m. capacity. According to the experiments made, under these conditions the resistance to motion in the ships will be but little more than in an open river. (2) For ships of war a width of 72.16 ft. (22 m.) is required for the bed of the canal, and a surface width of 190.24 ft. (58 m.) for ships drawing 25.4 ft. of water. (3) Throughout the body of the canal the depth should be 29 1-2 ft. (4) For the commercial marine the average maximum draft will be 21.3 ft. (5) The width at the keel level is established in such manner that two ships of 38.4 ft. beam can pass each other by exercising due care. Further than this, in curves of less than 2,500 m. radius the transverse profile is enlarged according to the formula

$$26 - \frac{\text{radius}}{100}.$$

Thus, for a radius of 1,000 m. the enlargement is 16 m. or 52.48 ft. The normal width has also been modified at certain passing points, where the length of the station is 1,476 ft. and the width at the bottom is 197 ft. At these stations ships of war can pass vessels of the merchant marine without trouble.

As shown on the plan, regular stations or "gares" are located at other points about 12 km. or about 7 miles apart.

The sides of the canal are covered, in the sections where granite is abundant, with a granite paving, 12 ins. thick, lying on a bed of gravel, 8 ins. thick (Fig. 7). In the western section, where stone is scarce, the sides are protected by slabs of beton, 8.85 ft. long by 4.92 ft. wide and 8 ins. thick.

The most important works are at the extremities of the canal and in the bridges crossing the canal. Fig. 3 shows the Elbe entrance to the canal. The canal ends at the origin of the river curve, where the depth of the water is 36 ft. at low tide. It was here deemed best to give the axis of the canal an inclination of 133 degrees with the axis of the river current, so that the strong current of the Elbe could pass without interfering with the mouth of the canal, and so that the waves would not be hurled directly upon the lock-gates. The greatest wave movement takes place with a west wind, and it sometimes happens that the surface of the water is agitated over an extent of 14 1-4 miles. The wind from W. S. W. and S. W. drive the waves towards the lock-gates and the double locks facilitate the departure and entrance of ships.

Fig. 7. Detail of Paved Slope.

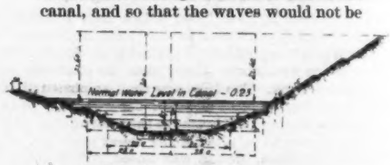

Fig. 6. Normal Section.

The total length of the locks is 719.8 ft., and the useful length is 492 ft. with a free width of 82 ft. The arrangement of the gates and the accessory installation differ little from those used in similar cases, the guard-gates included. The gates are handled by water under pressure. The dimensions here shown permit all ships of the commercial marine to enter the canal, excepting the fast steamers of the Hamburg-American Co. of 12,000 to 14,000 tons register. The entrance port has a mean width of 328 feet, and is funnel-shaped towards the Elbe. The sides are made by quay walls which terminate in lighthouses. The interior port has a length of 2,624 ft. and a width of 590 ft. The port and locks on the Baltic side are shown in Fig. 4, and are practically similar to that described for the North Sea side. The wave shock has less importance on this side. All lighting on both sides is done by electricity. To tie together the two sides of the canal there will be two drawbridges for roads, three railway drawbridges, one fixed bridge at Gruenthal and sixteen ferries, the chief of which latter will be operated by steam. The drawbridges will have an opening of 118 ft.

At the divide between the Elbe and the Eider, which is about 69 ft. above sea-level, the canal will have banks about 65.6 ft. high. The Gruenthal bridge, which crosses the canal at this point, has a single span of 513.3 ft. and the lower chord of the roadway is 137.7 ft. above the surface of the canal, leaving abundant room for the passing of ships be-

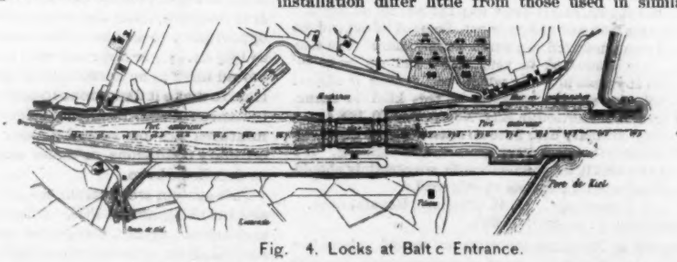

Fig. 4. Locks at Baltic Entrance.

neath. The Gruenthal cut contains about 15,000,000 cu. m. of material, and this will be used in forming the embankments in the low portions beyond. This bridge was illustrated in our issue of Aug. 1, 1891.

SOFT STEEL IN BRIDGES.

In our issues of Nov. 7 and Jan. 16 reference was made to a paper by Mr. Fred. H. Lewis, on the above subject, read Oct. 17, before the Engineers' Club of Philadelphia. The complete paper has just been published in the club proceedings, and also separately in pamphlet form by the author, for private circulation. (A few copies have been furnished to Engineering News Pub. Co. and will be mailed on receipt of 25 cts.)

Mr. Lewis advocates the use of soft steel in place of wrought-iron, and presents a bridge specification drawn to permit the use of soft steel with unit strains 8 to 10 per cent. in excess of those used for wrought-iron, and requiring in general no different shop treatment for the steel than for the iron. He prefaces his specification with an interesting discussion, which we abstract as follows:

Wrought-iron, soft steel and medium steel are the three metals offered to engineers for structural work. Of these, we are using wrought-iron for short spans and medium steel for long spans, while the soft steel which is in many respects the best material of the three, we are using very little, and there seems to be no immediate prospect under existing specifications of extending its use. But my intimate acquaintance with the character of the material now being turned out by our manufacturers has impressed upon me the fact that our neglect of soft steel is to the disadvantage of our bridge structures.

Wrought-iron is certainly not improving in quality; and in certain directions it is distinctively poorer than formerly. In steel, however, there has been a notable improvement in quality and uniformity. Compared with wrought-iron, soft steel has 15 per cent. higher ultimate strength, 20 to 25 per cent. higher elastic limit, and 50 to 60 per cent. greater ductility. It has equal strength, ductility and bending qualities lengthwise and crosswise of the material, while wrought-iron, strained across its grain, has little strength and ductility and will not bend. Further, steel has no fiber, and consequently has less disposition to tear and pull out; and, lastly, we have the fine finish and sound, clean metal characteristic of steel, in comparison with the rougher finish and frequently doubtful welding of wrought-iron.

Now, in certain well-known specifications, and with the tacit consent of many engineers, our bridge builders have been privileged, for several years past, to use soft steel on the same basis as wrought-iron; at no time, however, have they taken advantage of this privilege to any great extent, and it seems quite uncertain whether they will do so. The very simple reason is that it costs more.

It seems likely that if there is a considerable market for it, under a standard specification, that the cost of steel will be reduced to that of wrought-iron or lower; but it seems likely that this will not transpire until we do use it, and cheapen it by making a market for it.

Within a few years quite a number of engineers have essayed to use soft steel, but not under proper conditions. In one or two cases they are reaming it, just as they would medium steel; but the metal is not adapted to reaming, being of a soft, waxy texture, so that it rapidly clogs a tool, making the work more expensive than on medium steel; and we are not warranted in figuring the unit strains enough higher to cover this expense. Other engineers have used soft steel under the same conditions as wrought-iron, but with the higher unit strains which have been adopted for medium steel. It is not necessary, however, to figure it so high to place it on a par in cost with wrought-iron; and further, the metal is lower in both elastic limit and ultimate strength than medium steel.

The increased weight of steel over wrought-iron is about 2 per cent., and the increased cost per lb. (not well maintained) is about 5 per cent. Thus the cost of soft steel is nominally a little over 7 per cent. higher than wrought-iron. In the shop there would be a slight saving in soft steel; a rivet can be saved here and there, and there will be other small savings if it can be used just like wrought-iron.

I take it for granted that the propriety of using soft steel, having an average ultimate strength of 58,000 lbs., at unit strains in compression 10 to 15 per cent. higher than wrought-iron, will not be seriously questioned. I mean by this under the actual conditions in which it is used in our bridges—that is, with (l) divided by (r) not over 150. The propriety of using soft steel under higher unit strains than wrought-iron hinges then upon its qualities in tension in flanges of girders and in the tension members of trusses; and this phase of the subject I propose now to discuss: Whether soft steel, after punching, constitutes a good tension member.

If left to our practical shopmen, there would probably be no hesitation whatever on this score. It is, perhaps, no exaggeration to say that for exacting conditions of all sorts it is becoming more and more the practice to substitute soft steel. It is being used for latticing, because it will not split; it is being used for the hitch angles of stringers and floor beams, because it will not crack; it is being used for pin plates on suspenders, and in various other ways where its superior qualities have been practically shown to practical men.

It is necessary to get more conclusive evidence than this, however, and the presentation of this evidence, as I have been able to collect it, follows below.

Let me say at the outset that there is no attempt to show that reaming in itself is not a good thing. On the contrary, the tests below show that it generally benefits soft steel whenever the metal is over 3-8 in. thick. But, as stated above, we cannot ream soft steel and use it in competition with wrought-iron, and hence the question to be considered is whether we are as fully warranted in punching soft steel as in punching wrought-iron. If soft steel retains its strength and elasticity after punching as well as wrought-iron, we are clearly free to use it in the same way.

The first evidence submitted by the author is a series of tests of riveted joints, made in 1882-83, by the U. S. Government at Watertown Arsenal. All rivet holes were punched, and steel of 51,000 to 57,000 lbs. tensile strength was compared with iron of 44,000 to 48,000 lbs. tensile strength. The riveted joints were tested for ultimate tensile strength, and the strength of the net section was compared with the original strength of the metal. The plates tested were 1-4 in. to 3-4 in. in thickness, and for each thickness both single-lap and double-lap joints were tried. In 33 comparative tests, not only did the steel show much less average loss in strength from punching than the iron, but in every test but one made the steel was the superior. In the test of plates 1-4 and 3-8 in. thick, the iron showed a strength for the net section averaging 2 per cent. in excess of the original strength of the material; the steel showed a strength averaging 16 per cent. in excess of its original strength. With the plates 1-2 to 3-4 in. thick the iron showed an average loss of 19 per cent., and the steel showed a gain of 5 per cent. on the 1-2-in. plates, a gain of 14 per cent. on the 5-8-in. plates, and a loss of 11 per cent. on the 3-4-in. plates.

A second series of tests was made on the same lot of material, comparing the relative effects of drilling and punching on test specimens. Again, the iron showed considerable more injury from the punching than the steel.

Mr. Lewis next instances a series of 50 or 60 tests recently made in a large steel works on bars 6 ins. wide and 1-2 to 3-4 in. thick, in which 64,000-lb. steel is compared with 52,000-lb. iron. Punched, reamed and drilled specimens were compared. The results showed very uniformly less injury by punching to the steel than to the iron, the average difference being about 10 per cent. Moreover, the iron showed quite as much benefit from reaming as the steel.

In a third table the author gives the results of a series of tests, made under direction of the Pittsburg Testing Laboratory, in which soft steel and wrought-iron are again compared, in both punched and reamed specimens. The elastic limit, as well as the ultimate strength was determined, and it was notable that in both steel and iron, but especially the former, the elastic limit was raised by punching in almost every case, the pressure of the punch and die seeming to harden the metal.

In a series of tests with rivets driven in the holes it was evident that the rivet acted as a splice, and the elastic limit was really that of the gross section. The tests hardly indicated on their face such high values, but this was explained by the fact that the heating in riveting softened the metal and reduced the elastic limit.

Tests of medium steel and hard steel were made in the same connection and showed a smaller loss of strength of the medium steel from punching than the loss in wrought-iron. For hard steel (81,000 lbs. strength), however, the loss was somewhat greater.

These experiments, Mr. Lewis believes, tend toward the following conclusions, although by no means prove them: (1.) The thicker the metal the greater the injury in punching steel. (2.) The softer the steel, the less the injury in punching; but, (3), the first conclusion is the major factor, the grade of the steel making much less difference than the thickness of the material. (4) The effect of riveting is advantageous, increasing the values of the net sections.

Conclusions 1 and 2 have ample support from other sources, and may be considered as facts, and some of Kirkaldy's experiments and discussion are quoted in their support. Practical deductions from these conclusions are that, since punching is more injurious to thick plate, it is desirable to use moderate sections in tension members and in floor beams, stringers and girders subject to impact. We quote verbatim from the paper as follows:

Having thus reasonably demonstrated an equal standing for punched steel, we could logically claim for it unit strains from 12 to 15 per cent. higher than for wrought-iron. In the specifications, however, it was thought well to be conservative on this point, especially as it is not necessary to figure soft steel so much above wrought-iron in order to make the cost practically the same. The unit strains, therefore, for soft steel in tension are placed at 8 per cent. higher than wrought iron, and in compression 10 per cent. higher. These figures are conservative, and the balance left over is so much advantage to the structure.

It will be observed that web plates are required to be of steel in all cases. It is, of course, impracticable to reach web plates by difference in unit strains. It would, however, be absurd to use steel angles in connection with an iron web, since the equal strength of steel plates in all directions exactly fills the condition of a web sheet, and makes them particularly desirable for such purposes. There is, besides, good reason for throwing iron web plates out altogether, because of poor quality. It is doubtless no longer profitable to make a first-class iron web plate, hence many of those now sold are of very doubtful quality, and owe whatever virtues they possess to the percentage of steel which they contain.

It will be noted that both iron eye-bars and soft steel eye-bars are ruled out of the specifications. Excepting with the most conservative, the iron bar has already been practically superseded, because steel bars are now cheaper and have, besides, abundantly demonstrated their superiority. As regards soft steel bars, there is no reason, on the fact of it, why soft steel should not make a good eye-bar; it doubtless would; but medium steel has been found to answer the requirements with entire satisfaction, and after annealing is considerably softer than when tested in its natural state in small specimens.

There is a practical reason also for not using soft steel in the fact that it is more apt to have piping and blow-holes in it than medium steel. This is not objectionable in angles or plates, where these defects close up and disappear; but it is objectionable in large masses, like pins and forged bars. It was not thought worth while, therefore, to introduce a soft-steel eye-bar in the specifications. The result is that the soft steel is limited to compression members, to girders, and to riveted tension members; and the idea in fixing the unit strain has been to place it for these purposes on a par with other material, possibly to give it a little advantage to overcome the inertia of manufacturers who have been accustomed to using wrought-iron only.

There is one point more that may require special mention—that is, the provision of the specifications permitting steel bars to be used with upset screws on their ends. This is probably the last point which engineers are ordinarily willing to concede in regard to steel; that is, the possibility of putting a screw-thread on it; nevertheless this may be done with entire success.

In proof of this, Mr. Lewis submitted tests made at Edge Moor Bridge Works, by the Pittsburg Testing Laboratory, of three eye-bars having upset screw ends connected by a turnbuckle. The tests are summarized as follows:

Tests at Edge Moor Bridge Works of Steel Eye-Bars with Upset Screw Ends.

Size.	Length.	Elastic Limit. Lbs. per sq. in.	Ultimate Strength. Lbs. per sq. in.	Elongation, per cent.	Reduction, of area, per cent.	Remarks.
5x7-8 in.	37 ft. 1 in.	50,370	61,620	12.66 (33 ft.)	48.08	Broke in long end.
4x7-8 in.	31 ft. 6 in.	37,700	59,240	15.63 (27 ft.)	51.42	Broke in short end.
5x7-8 in.	37 ft. 0 1-2 in.	38,170	62,470	11.71 (33 ft.)	49.49	Broke in long end.

It will be seen that to put a round screw end on a 5x3-4-in. bar is a most difficult upset; and the fact that it was successfully done speaks highly for the character of the material. Some steel stirrup hangers have also been recently made by the Edge Moor Works, and although the excess of area at the root of the thread was but 7 per cent., none of the hangers broke in the thread when tested to destruction. The material used in these hangers was ordinary round steel, taken from stock which had been ordered for cotter pins.

(To be continued.)

SAND AND STONE USED FOR CEMENT MORTAR AND BETON.

An interesting pamphlet with the above title is published in Paris by M. Feret, Chief of Laboratory, "Ponts et Chaussées," at Boulogne-sur-mer, and from it we make the following very full abstract:

Commencing with sand, the author remarks that it is usual where mortar is being made in great quantities to measure the sand by volume and the cement by weight. This is logical, for with the sand the point to be considered is the volume of the mortar made, which differs little from the volume of the sand, as the cement fills the voids. But, on the other hand, the measurement of the sand by volume is not so exact as weighing it, and this practice gives rise to important errors in gaging. The experiments here given, pointing out these errors, were made in the Boulogne laboratory, established for the control and study of Portland cement.

In the first place, the calculated weight of a cubic meter of sand varies with the size of the gage or measure used, even when effort is made always to fill it in the same manner and with as even a settlement or packing as is possible. Generally, the greater the depth of the gage the more the sand packs by its own weight, and the greater the weight per cubic meter. It is evident that the manner of pouring the sand into the gage will influence its packing, as will the quantity of sand handled at a time, the height from which it falls, the shaking of box during the filling, the variable packing due to the stroke of a plate or shovel on the sand surface, and the more or less exact "striking" of the full measure; all of these points are factors that must be accounted for and specified in detailing experiments.

Besides this, the effect of this manipulation is not the same for all sands. While the effect is relatively light for sand of large and nearly uniform size, it augments rapidly with sand of mixed sizes, and is especially great when the sand contains a considerable proportion of fine powder or dust.

One of the principal causes of error in gaging cement mortar is occasioned by the packing of the sand in the gage varying widely with the degree of humidity in the sand; for, up to certain limits this humidity causes the sand grains to stick together and prevents their packing. Experiments were made with two different sands, the one very fine, from the sand dunes of Boulogne, and the other coarser. These sands were shoveled into an ordinary sand-measuring box of 50 liters capacity in as regular a manner as possible. Each box of sand was previously well dried in the sun, and water was then added in increasing doses. After each new dosing with water the sand was well mixed and the weight of the contents of the 50-liter box was ascertained. The weight of a cubic meter of sand in the same condition was then deduced and the dry sand in each cubic meter of humid sand was ascertained. The following table gives the result.

	Kilograms.						
Proportion of water to 100 kg. of dry sand.....	0	0.5	1	2	3	5	10
	Grams.						
Loss of weight by drying per kg. of humid sand.	0	5.0	9.9	19.6	29 1	47.6	90.8
Dune sand:	Kilograms						
Weight of 1 cu. m. of humid sand.	1,458	1,310	1,238	1,213	1,209	1,208	1,266
Dry sand in 1 cu. m. of humid sand.....	1,458	1,304	1,226	1,189	1,174	1,151	1,149
Coarse sand:							
Weight of 1 cu. m. of humid sand.....	1,514	1,463	1,412	1,300	1,221	1,229	1,305
Dry sand in 1 cu. m. of humid sand.....	1,514	1,456	1,398	1,235	1,185	1,171	1,187

It is seen that a very slight proportion of water added is sufficient greatly to lower the weight of sand in a cubic meter. Thus 2% of water reduces the weight of the sand 20%, as compared with the same measure of dry sand. As the degree of humidity increases the weight tends toward constancy, or even increases slightly. The author then gives the following table, showing the influence of the humidity of dune sand in the dosing of mortars:

Dune sand: Dosage to obtain wt. of cement per cu. m. of dry sand.	Dosage with humid sand. Kilograms.						Wht. of cement to be used per cu. m. of humid sand to obtain the proposed dose. Kilograms.				
Water per 100 kg. of dry sand	0	0.5	1	2	3	5 to 10	0	0.5	1	2	3	5 to 10
200	221	278	245	249	254	179	168	163	161	158
300	335	357	368	373	281	269	253	244	241	236
400	446	486	490	497	508	359	336	316	321	315
500	559	595	612	621	634	448	421	408	402	394
600	670	714	735	745	761	538	505	489	482	473
800	895	951	980	995	1,015	716	671	652	643	630
1,000	1,119	1,190	1,226	1,242	1,270	895	840	816	804	788

As a general result it may be said that mortars are richer in winter than in summer, and mortars made after a long dry period should be mistrusted as being more meager than usual.

The law controlling the packing of sand according to its relative humidity ceases to be exact when the proportion of water passes a certain limit; and this limit is more quickly reached as the proportion of fine sand grains increases. When the limit is passed, the packing increases with the quantity of water, and may be greater than that with dry sand. One of the usual methods of hastening the settlement of a sand filling is to water it heavily. When a measure of dry sand has water poured upon it, the level in the measure at once sinks, and the volume of the sand and water is less than that of the dry sand. Nevertheless, this method does not give the exact measurement of the packing. It is better to allow the water to arise from the bottom of the vessel containing the sand, for by thus mounting progressively toward the sand surface the water is enabled to drive out the air which it replaces. It should also be stated that in any event, the results obtained would vary with the nature of the sand and the form and capacity of the vessel containing it.

M. Feret also tried the experiment of diluting the sand with a quantity of water until it was in the form of a very thin paste, and this paste was then turned out into a graduated glass. After leaving it stand some hours, the excess water rose to the top and the volume occupied by the wet sand could be read. In this way it was found that one liter of dune sand measured dry and without packing, occupied, when saturated with water, only 0.888 liter.

From the varying results of these experiments the author concludes that not much reliance can be placed upon the ordinary method of determining the minimum proportion of cement that should be combined with a given sand to obtain a compact mortar. Practically, the weight of the cement is calculated according to the voids existing in sand measured more or less dry and more or less packed, a volume that is shown to be extremely variable and very different from the voids actually existing between the sand grains when this sand is used in connection with cement and water in the manufacture of mortar, and after the more or less extended manipulation of the paste thus formed. If we admit for the moment that the true voids to be filled would be comparable to those in sand saturated with water, say 0.375 of the volume, we find that in sand with 5% humidity the voids would be represented by 0.567, a difference in results rating as 2 is to 3.

Mr. Feret gives the following table to show the varying weights and voids in a cubic meter of sand under the varying conditions given:

Conditions of the Experiment.	Calculated weight for dry sand in 1 cu. m. of the same tested. kg.	Volume of water or voids between grains of sand of a specific gravity of 2.65. cu. m.
Dry sand turned by a shovel into a box of 50 liters.....	1,458	0.450
Wet sand measured in same way.....	1,458 to 1,149	0.450 to 0.567
Dry sand placed without packing in a 1 liter box.....	1,471	0.445
Dry sand packed to refusal by shaking, in 1 liter box...	1,721	0.350
Sand saturated with water and measured in a glass....	1.653	0.375

In the case of sand containing pebbles the weight per volume should be heavier than the sand alone, because the pebbles represent solid matter filling voids that would otherwise be filled by sand grains with voids between. In his experiments M. Feret took gravelly sand from the coast and passed it through a sieve of four meshes per sq. cm. For pebbles he took two kinds, one passing a ring of 10 mm. diameter and held by the sieve above described, and another equal part passing a ring of 30 mm. and held by the 10 mm. ring. He gives the result in the following table:

Proportion of sand in weight.									
100	97	91	85	70	55	40	25	10	0
Proportion of pebbles.									
0	3	9	15	30	45	60	75	90	100
Weight of 1 cu. m. of the mixture determined in a 50 liter box, kg.									
1,600	1,625	1,656	1,686	1,744	1,769	1,730	1,604	1,473	1,386

To practically show the effect of this mixture of sand and pebbles in a cement mortar, the author presents the following comparison: Taking a mortar with X kilograms of cement per cubic meter of sand containing 15% of pebbles, we have

Cement, kg. X
Sand, kg. $1,686 \times 0.85 = 1,433$ } mortar proper.

Pebbles, kg. $1,686 \times 0.15 = 253$, buried in the mortar

While in a mortar with X kilograms of cement per cubic meter of pure sand, the proportion stands

Cement, X kg.
Sand, 1,600 kg.

In this comparison it is supposed that the proportion of pebbles is not too great. But, in any case, the engineer can free himself from sources of error due to pebbles by eliminating them by a sieve, and always working with pure sand. In the Boulogne laboratory it is the practice to consider as pebbles material that is retained by a sieve of four meshes per sq. cm.

Generally, when it is desired in laboratory experiments to study the effect of the size of sand grains upon some certain property of mortar these grains are reduced to standard sizes by successive sieving, resulting in a series of sand grains in which the grains are practically of the same size in each series. In the limited case where each sand is composed of grains rigorously equal and of the same form, these grains when poured in a uniform manner into a measure should group themselves according to a common law, so that no matter what their common size may be they would geometrically so arrange themselves that the voids would proportionately differ and the weight of a cubic meter of sand would be independent of the size of the sand grains.

M. Feret points out the practical difficulties of comparing natural sands to be used in mortar with single standards so obtained, and suggests as a better plan the following: In so complicated a problem he thinks it is safer and easier to compare all sand to be used with a limited but sufficient number of selected and studied types composed of a mixture of standard sands of variable proportions and different dimensions. He calls this the "granulometric" method, and describes it as follows:

The sand to be used is first cleaned of all pebbles by passing it through a sieve of four meshes per sq. cm., thus obtaining a sand of all sizes of grains from zero to the largest that will pass this sieve. Then by a series of differing sieves this sand is separated into a series of uniform sizes which can again be combined in varying proportions of different dimensions. We then have an artificial mixture with known constituents, and with these mixtures as standards natural sands deprived of pebbles can be compared.

To secure this end without multiplying too much the standard mixtures M. Feret separates his sand into three series of definite grains, as follows:

Large grains, G	Passing a sieve of 4 meshes per sq. cm., and held by one of 36	"	"	"
Medium grains, M	Passing a sieve of 36 and held by one of 324	"	"	"
Fine grains, F	All that pass a sieve of 324	"	"	"

Then with these sands all the combinations are made that are possible with each mixture composed of 10 equal parts. There will be 66 distinct granulometric types, in which each symbol G. M. F. will have affixed an exponent showing its proportion in the mixture, and the sum of these exponents must always be equal to 10. In these experiments ground Cherbourg quartzite was used of a density of 2.65. It was handled very dry and placed with a shovel into a box of 50 liters (20 cm. deep). It was found

that the weight, practically the same for the three sands used pure, increased rapidly as the mixtures became more complex and reached a maximum of 1,686 kg. in the mixture $G^2 M^2 F^4$. The minimum weight was 1,302 kg. for the sand M, pure, a difference of more than 30%. This variability in weight per cubic meter, according to the granulometric composition of the sand grains, must necessarily result in notable differences in the production and composition of mortars.

The weight per cubic meter of sand, however, will differ susceptibly with the form of the grains, for the relative disposition of the grains in the gage must necessarily differ somewhat with their form. An experiment is given by M. Feret to prove this, with four sands of different forms, with the same granulometric composition ($G^3 M^3 F^3$):

Volume of voids remaining in 1 liter of sand.		
Nature of sand.	Unshaken, cu. cm.	Shaken to refusal, cu. cm.
Natural sand with rounded grains	359	256
Cherbourg quartzite, angular grains	421	274
Crushed shells, flat grains	443	318
Residue of Cherbourg quartzite crushed between jaws, laminated grains	475	346

It will be noticed that the voids increase as the grains become less regular in form.

M. Feret then concludes that in the fabrication of mortars it results from the preceding experiments that the engineer should guard carefully against the errors due to the methods of measuring the sand, and especially against the effects of humidity in the sand as noted. The granulometric composition of the sand will, however, vary with the end in view.

If the only purpose is to fill a great void with the least material possible, it will be advantageous to use a very regular sand, that is, sand containing the greatest proportion possible of grains of the same size. If, on the other hand, a compact and resisting mortar is desired, such, for example, as is used in fortification work, use should be made of a sand containing grains of all dimensions. It would be very advantageous to use a mixture of two sands of very different sizes, with as few grains of intermediate size as possible.

M. Feret then takes up the subject of small stone, using this term in a generic sense as applied to matter made up of pebbles or broken stone, just as sand is made up of grains. This study is important in connection with the manufacture of beton. In considering the packing of small stone it is evident that, in connection with the considerable weight of each pebble, capillary action or humidity may be practically neglected, as far as it more or less affects their gliding one upon the other, or in packing. But the granulometric composition has quite as much importance as in the case of sand. To prove this an experiment was made by separating the small stone into series of sizes by passing them through open boxes with a bottom of sheet metal pierced with circular holes of different sizes. Each class of assorted pebbles was then well mixed with a shovel and placed into a cubic measure (50 cm. on the side and holding ⅛ cu. m.), and then "struck" and weighed. The result is given in the following table:

Composition, in weight, of small stone.				Cubic meter of Round pebbles, (density, 2.56).		Cubic meter of Broken Stone (density, 2.65).	
Pebbles passing a ring of 90 mm.	60 mm.	40 mm.	20 mm.				
And held by a ring of 60 mm.	40 mm.	20 mm.	10 mm.	W'ht kg.	Volume of voids. Liters.	W'ht kg.	Volume of voids. Liters.
	1	0	0	1.536	400	1,235	534
	0	1	0	1.56	388	1,220	517
	0	0	1	1,493	417	1,270	521
	1	1	0	1.644	358	1,312	505
	1	0	1	1.630	356	1,402	471
	0	1	1	1.590	379	1,338	495
	1	1	1	1.648	355	1,382	478
	4	1	1	1.676	345	1,346	492
	1	4	1	1.623	366	1,339	494
	1	1	4	1.582	381	1,363	486
	8	0	2	1,687	341	....	....
1	0	0	0	1,501	414	1,266	521
1	4	1	1	1,702	335	1,356	488
1	1	4	1	1,638	360	1,365	485
1	1	1	4	1,648	356	1,420	464

These figures show, as in the case of sand, that the settlement or packing was least in the classified pebbles measured separately as classes, and almost independent of their size, while the packing increases as the mixture contains less and less of one predominating size. The difference in packing is less in proportion, however, than in the case of sand.

As to the effect of form in a mass of small stone it is noticeable in the table that the weight per cubic meter of rounded pebbles and broken or angular stone differs widely. The packing of round pebbles, whatever may be their granulometric composition, is notably greater than the packing of broken stone. On the other hand the mean volume of pebbles, coming from two sieves of consecutive sizes, differs enormously according to the form of the pebbles, as is shown below, with pebbles taken up at random and weighed in mass:

Pebbles passing a ring of diameter of (mm.)	90	60	40	20
and held by " " "	60	40	20	10
Mean volume { round pebble (cu. cm.)	162	46	11	1.6
of a pebble { broken stone "	91	30	7.5	1.1
Proportion of 2d volume to 1st	0.56	0.65	0.68	0.69

The general rule for the manufacture of beton is to use pebbles absolutely free from sand and earth, well washed and still damp; then mix intimately the pebbles and mortar, and finally ram the beton energetically in place. As far as the experiments recited have to do with the making of beton, the advice is identical with that given for the use of sand. The pebbles should be nearly equal in size if we wish simply to fill a great void with the least material; or use pebbles of different sizes when the beton is to be compact and resisting. It may be added that the employment of rounded pebbles will generally give a beton better locked or bonded than if angular stone is used, and will require a smaller proportion of mortar. But it is, on the contrary, to be feared that the adhesion of the mortar to round pebbles is less than to angular stone, and the advantage gained in one direction may be lost in another.

To test the granulometric qualities of broken stone used in beton, the following experiment was tried at Boulogne: Four blocks were made with broken stone of different granulometric composition, with mortar made of one part by weight of cement to three parts of Boulogne gravel, gaged with water to an amount equaling 17% of the total weight of the sand and cement. These cylindrical blocks were 0.4m. high and the same in diameter, and cubed 50 liters.

The volume of mortar used was calculated to represent exactly the volume of the voids in the dry stone. After a thorough mixing this beton was placed by a shovel in small quantities into a mold and rammed energetically with each dose of beton added. After being exposed for four months to the air three blocks were weighed and then cut with a marble saw into cubes of 0.1 m. on the side, making 12 cubes from the center of each cylindrical block, and giving four cubes for each of three consecutive horizontal layers of the original block. These cubes were then carefully compared and marked and were immersed in sea-water for one month and finally crushed in a machine normal to the layers of beton as made. The table below shows that—(1.) In each block the lower layers, which had been submitted to longer continued ramming than the upper layers, offered a greater resistance. (2.) The mean resistance varied according to the granulometric composition of stone used, and was greater with the increasing proportion of large stone in each block.

Other blocks of beton were then made in the same manner, using rounded quartz pebbles instead of broken stone, and a quantity of mortar sufficient to fill the voids. Though these betons were less rich in mortar than the others they looked compact enough as made. After drying their average weight was found to be 2310 kg. per cu. m., which was a little higher than that of broken stone beton. But unfortunately it was found to be impossible to cut these blocks into cubes for the test of resistance. The table is for betons, 1 to 3, 17% water:

Granulometric composition (broken stone).			Vol. of voids per cu. m. of stone.	Vol. of mortar per cu. m. of stone.	W'ht. of cu.m. of beton.	Mean resis. in kg. per sq. cm. Of the 4 cubes tested from			Of 12 cubes the same block.
G	M	F	cu. m.	cu. m.	kg.	Top. kg.	Middle kg.	Bottom kg.	kg.
4	1	1	0.492	0.492	2296	144	143	172	153
1	4	1	0.494	0.494	2272	141	141	154	145
1	1	4	0.486	0.486	2276	106	121	123	120
2	2	2	0.478	0.478	2264	115	132	151	133

Mr. Feret cites an experiment as showing the influence of varying quantities of water used in gaging betons. The two betons experimented with were made in large amounts in a special mixing machine employed in constructing the new sea walls of the port of Boulogne. They were both composed of two volumes of crushed stone and one volume of mortar made with 450 kg. of cement per cubic meter of sand, but differed in the quantity of water introduced into the mixture.

In the first, which had a firm consistency, it seemed when the mold was filled that there was not enough of the mortar to fill all the voids between the small stone, notwithstanding the greatest possible ramming. The second beton presented a plastic appearance, was perfectly bound together, and flowed under the rammer in such manner as to make ramming difficult. When the blocks were sawed one month after their manufacture it was seen that while the second block was solid in all parts, the first presented some small voids, but these were much less than would have been supposed from its appearance when made. Nevertheless the density found for the two blocks was practically the same, and the drier block, No. 1, gave a much greater resistance that block No. 2, or the wet one. These results are shown in the following table:

Mean resis. in kg. per sq. cm.			For four cubes from			For 12 cubes from same block kg.
Composition of the betons.	Consistency.	W'ht. per cu. m. kg.	Top. kg.	Middle kg.	Bottom kg.	
2 volumes of stone + 1 vol. of mortar, made with 450 kg. of cement to 1 cu. m. sand.	Firm	2,326	158	158	171	162
	Plastic	2,300	112	108	101	107

It should be noticed here that while the dry beton observed the former law of being stronger in the lower and longer rammed layers, the wet beton, which could not well be rammed, obeyed an opposite law in having its top layer the stronger. M. Feret concludes that in all cases where beton work of great strength and resistance is required it is best to make the beton rather dry, and depend upon vigorous ramming for the bond and homogeneity. On the other hand, beton of the dry type is dangerous in masonry subject to contact with sea-water, for voids do exist in it, and the chief quality of this class of work is that it should prevent access to its interior of the decomposing elements always present in sea-water.

Grounding the neutral wire in the three-wire system of electrical distribution has been practiced for some time by the Edison Electric Co., partly as a precaution against lightning. The New York Board of Fire Underwriters has just ordered the practice discontinued in New York city, the action being based largely on a report from President Henry Morton of Stevens Institute. The objection to the grounding is that the entire system of conductors is then in such communication with the earth that the contact of either the positive or negative conductors with water, gas or steam pipes or iron parts of a building or other conductor will establish a connection through which a large current will flow. Further, such grounding renders impossible any testing by which the insulation of the system can be determined from time to time. On the other hand, the Edison Co. claims that the grounding of the neutral wire increases instead of diminishing safety, and that no less copper is used and no less care is taken to secure good insulation. The practice is in vogue in several other cities with the approval of the fire underwriters.

A great feat in the electrical transmission of power is to be undertaken by the Westinghouse Electric Co. in southern California. It is stated that a contract has been closed with the San Antonio Light & Power Co., of Pomona, Cal., for transmitting nearly 1,000 E. HP. a distance of 15 to 30 miles. The power plant will be located in the San Antonio Canyon, about 15 miles from Pomona, where a fall of 425 ft., with a minimum flow of 1,300 cu. ft. per minute, is available. To develop this power a rock tunnel 1,300 ft. long and a steel pipe line 2,000 to 2,500 ft. in length will be required. At the power station the water will be used to drive Pelton wheels directly connected to Westinghouse alternating current dynamos, generating a current of about 1,000 volts potential. This will be increased to 10,000 volts by the use of transformers, and will then be led over bare hard-drawn copper wires to Pomona, 15 miles, and to San Bernardino, 30 miles distant. Step-down transformers will be located at these points, reducing the potential to 1,000 and 2,000 volts. The lower pressure will

be used for local distribution, while the 2,000 volt current will be transmitted to nearby towns. Other transformers will be used to reduce the potential to 100 volts for lighting purposes. The insulators used will be similar to those in the Lauften-Frankfort plant, with oil receptacles. The half-dozen towns which this projected plant will reach have a population of about 25,000; and as gas oil and coal are very high, the advantages of electric light and power will be unusually great.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

OTTAWA & GATINEAU VALLEY.—Work is reported in progress upon the fourth 10-mile section of this railway, from Ottawa, Ont., north, along the Ottawa River.

CONCORD & MONTREAL.—Surveys will soon be commenced for a branch from Jefferson Meadows, N. H., to the Waumbek House, about 3 miles. The line will be built at once to provide for the present season's traffic.

ROCKAWAY VALLEY.—It is stated that work will soon begin on the extension from Mendham to Morristown, N. J., about 8 miles. J. V. Melick, White House, N. J.

CANADA ATLANTIC.—Estimates are being prepared for the construction of the proposed line from Ottawa to Emsdale, Ont., It is stated that a very favorable line has been secured, and that construction will begin in the spring.

SANDUSKY & COLUMBUS SHORT LINE.—The contract for constructing the entire 108 miles of this line from Bellevue to Columbus, O., has been let to Stearns & Hoover, of Columbus, O. Work is to begin in 15 days, and the line is to be completed by Sept. 1.

Projects and Surveys.

MT. FOREST & MEAFORD.—It is stated that steps are being taken toward the early construction of a railway from Mt. Forest to Meaford, Ont., about 45 miles. Among those interested are: W. R. Evans, Meaford, Ont.; J. H. Brown, Durham, and W. J. Mararlane, Markdale, Ont.

PHILADELPHIA & BUSTLETON.—Chartered in Pennsylvania to build a railway from a point near Frout St. and Erie Ave. to a point near the junction of Hoff and Boreau Sts., in Philadelphia, Pa., a distance of 8 miles. Among the incorporators are: Rich. W Clay, Wm. F. Dixon, Chas. P. Tomlinson; all of Philadelphia.

PHILADELPHIA & FRANKFORD.—Chartered in Pennsylvania to build a railway from a point on the Philadelphia, Newtown & New York R. R., near Crescentville Station, to a point on the west side of Frankford Road between Unity and Sellers Sts., Philadelphia. Among the incorporators are: Wm. A. Foulkrod. Philadelphia, Pa., Pres.; Wm. Bault, Jas. Whitteker, Samuel W. Evans, Jr., and David C. Nimiet, all of Philadelphia.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—Walter A. Osmer, Ch. Engr., Logansport, Ind., writes us that the preliminary surveys have been completed, and location is now in progress for this proposed line from Logansport, Ind., via Young America, Russiaville, Kempton, Sheridan, Augusta and Joliet to Indianapolis, Ind., a distance of 70 miles. The route is through a rich agricultural country, affording easy work; maximum grade 30 ft. per mile and maximum curve 3 degrees. About one-third of the right of way has been secured and $108,000 in local aid obtained. The principal business of the road will be in live stock, grain and the local freight and passenger traffic. It is not definitely decided when contracts will be let. Prest., Edward N. Talbot, 56 La Salle St., Chicago, Ill.

UNADILLA VALLEY.—Delos E. Culver, 145 Broadway, N. Y. City, Ch. Engr., writes us that the contract for building this road will be let about May 1, the work to be completed in September. The line as surveyed, is to run from New Berlin, N. Y., via South Edmeston, Columbus, West Edmeston, Leonardsville and Onadilla Forks, to Bridgewater, N. Y., 20 miles. About three-fourths of the right of way has been secured, and $50,000 in local aid promised. The other capital will be obtained by syndicate subscriptions to capital stock. The construction work will be very easy; maximum grade 30 ft. per mile. Geo. A. Scott is President and F. F. Culver, is Secretary.

READING, LANCASTER & BALTIMORE.—S. C. Slaymaker, Ch. Engr., Lancaster, Pa., writes us that this railway is projected to run from Reading, Pa. via Adamston, New Holland and Strasburg, Pa., to Perryville, Md., a distance of 75 miles. No surveys have been made yet, but they may be commenced in a short time. The route is through a good agricultural and mineral country, and the principal business of the line will be in farm products, iron ore, coal and sandstone. There will be no bridges of any importance. H. E. Lehman, of Lancaster, Pa., is President.

FOREST CENTRAL.—This company, whose incorporation was noted in our issue of March 5, will, it is stated, build its proposed line from Tionesta to Kellettville, Pa., 15 miles, this season. F. F. Witteken, Tionesta, Pa., Pres. and Ch. Engr.

TIADAGHTON & FAHNESTOCK.—Chartered in Pennsylvania to build a railway from Tiadaghton Station to Fahnestock Creek, Tioga Co., Pa. Pres., Jacob Schleffelin, Tioga, Pa. Principal offices, Tiadaghton, Pa. ton, Pa.

WESTERLY & JEWETT CITY.—W. G. Smith, Waterbury, Conn., Ch. Engr., writes that the surveys for this proposed railway from Westerly, R. I. to Jewett City, Conn., were made in 1890-91, and that the road will be about 28 miles long. The work will be light; maximum grade 2 per cent. and maximum curve 10 degrees. Pres., A. B. Briggs, Ashaway, R. I.

CLEARFIELD CREEK.—Chartered in Pennsylvania to build a railway from Belsena to a point near the mouth of Clearfield Creek, Clearfield Co., Pa., 15 miles. Treas., A. W. Lee, Clearfield, Pa.

ST. LAWRENCE.—Chartered in New York to operate 6 miles of railway from the International line in St. Lawrence Co., N. Y., to a connection with the Utica & Black River Valley R. R.

KETNER, ELBON & SHAWMUT.—B. E. Cartwright, Ridgeway, Pa., Pres., writes that this railway is projected to run from Ketner, Pa. via Glen Hazel, St. Marys and Elbon, to Shawmut, Pa., about 40 miles. Twelve miles of the road are completed and in operation, and the preliminary survey has been made for the remainder of the line. It is expected to let the contracts for further construction about July 1. The work will be light; maximum grade 90 ft. per mile. The road is being built in the interest of the coal companies along its route and its principal business will be in coal and lumber. Alferd Herdman, of Ridgeway, Pa., is Chief Engineer.

Southern.—Existing Roads.

NORFOLK & WESTERN.—This company has let the contract for building the Big Tom Branch to L. H. Vaughan, of Roanoke, Va. This branch leaves the Clinch Valley Division at Coeburn, Va., and will tap an extensive coal field, which, a correspondent informs us, will compare favorably with the Connellsville and Pocahontas regions. There are already a number of operators in the field making ready to ship coal.

RICHMOND, NICHOLASVILLE, IRVINE & BEATTYVILLE.—It is stated that the United States Court has ordered the receiver of this road to make surveys and estimate the cost of completing the road from its present terminus at Irvine, Ky., to Beattyville, Ky.

NORFOLK & CAROLINA.—It is stated that this company has begun surveys for a branch from Aulander, N. C., via Windsor, N. C., to Avoca, N. C., about 40 miles.

Projects and Surveys.

CARABELLE, TALLAHASSEE & NORTHERN.—It is stated that the contract for building 10 miles of this proposed railway from Tallahassee, Fla., to Thomasville, Ga., has been let to W. R. McIntyre and W. H. Mitchell, of Thomasville, Ga.

JACKSONVILLE & MAYPORT.—J. N. C. Stocton, of Jacksonville, Fla., is President of this Florida road.

BARTOW & PLANT CITY.—This company, whose incorporation was noted in our last issue, proposes to built a railway from Bartow to Plant City, Fla., 22 miles. The headquarters of the company will be at Bartow, Fla., and J. H. Tatum is president and B. B. Tatum is Secretary.

GURLEY'S & PAINT ROCK VALLEY.—S. I. Wheatcroft, Gurley's, Ala., Ch. Engr., writes us that surveys are now in progress for this proposed railway from Winchester, Tenn., along the Paint Rock Valley via Gurley's to Deposit, Ala., 70 miles. The route is through a rich mineral region, and the principal business of the road will be in coal, iron and timber. All of the right of way has been secured, and a large amount of capital stock subscribed by the people along the route. The southern part of the line is through a level country, affording easy and cheap construction; but the northern part crosses the Cumberland plateau, and the work will be quite heavy. It is expected to let contracts for building the line in about a month, and to have a section of 10 or 15 miles in operation by July. The company was chartered in Jan., 1891. Frank B. Gurley is President.

MEMPHIS & ATLANTIC.—It is stated that the contract for constructing a portion of this road will be let by April 1. F. M. Abbott, West Point, Miss., Pres.

HUNTINGTON & KENOVA.—Chartered in West Virginia to build a railway from Huntington to Kenova, W. Va. Among the incorporators are: J. L. Caldwell, S. T. Vinson and R. H. Pritchard; all of Huntington, W. Va.

COAL RIVER VALLEY.—It is stated that this company, whose incorporation was noted in our issue of March 12, has engaged W. C. Reynolds, of Charleston, W. Va., to make the preliminary surveys for the first 20-mile section of its road, which it is under obligation to complete this year. The stockholders will meet in April to complete the organization of the company.

JACKSON, CARTHAGE & ALABAMA.—A bill has been introduced into the Mississippi Legislature to charter a railway company by this name.

Northwest.—Existing Roads.

ST. LOUIS, ALTON & TERRE HAUTE.—An exchange states that this company has let the contract for a branch from Tamora to Mt. Vernon, Ill., 31 miles; and also that it has decided to let contracts soon for a line from Marion to Maryville, Ill., 35 miles, with a branch to Tamora, Ill.

BURLINGTON & MISSOURI RIVER. A press dispatch says: "Reports of an important extension of the Burlington lines in the Black Hills have only this basis: That the company has let a contract for the building of eight miles of road into Ruby basin at the Black Hills. This is all the extension the company contemplates at present at this place. It is, however, laying the rails upon some 50 miles of completed grading to carry its northwestern extension west of Gillette, Wyo., to the foot of the mountain.

DULUTH, MISSISSIPPI & NORTHERN.—Grant, Foley Bros. & Guthrie, of St. Paul, Minn., are reported to have the contract for building this railway from a point on the Mississippi River, 40 miles east of La Prairie, Minn., north 36 miles.

DULUTH, MESABI & NORTHERN.—Work has begun clearing the right of way for this road from Duluth, Minn., north, and it is stated that grading will begin as soon as the frost leaves the ground.

JACKSONVILLE SOUTHEASTERN.—Surveys are in progress for the proposed line from Havana to Canton, Ill.

Projects and Surveys.

CHICAGO, GREENVILLE & SOUTHERN.—Chartered in Illinois to build a railway from a point on the Jacksonville, Louisville & St. Louis R. R., in Bond Co., Ill., to Murphysborough, Ill. Among the incorporators are Isaac L. Morrison, David W. Rider and Francis Hook, all of Jacksonville, Ill.

POCAHONTAS R. R. & IMPROVEMENT CO.—This company has been organized to secure the construction of a railway to Pocahontas, Ia.

CHICAGO, ALTAMONT & PADUCAH.—The officers of this company, whose incorporation was noted in our issue of March 12, are: Pres., J. B. Messeck; V.-P., Phidello Smith; Sec., E. C. Rhoades; and Treas., Thos. E. Feketo. The principal offices will be at East St. Louis, Ill.

CALUMET BELT.—Incorporated in Illinois to build a railway from a point on the South Chicago R. R., at the intersection of Erie and South Chicago Aves., southeast to a point on the Indiana line in Thornton township, Cook Co., with a branch west to a point on the Illinois Central R. R., between Kensington and Harvey.

CHICAGO & ASSINBOA.—A railway company by this name has been chartered in Iowa. Among the incorporators are: Chas. E. Bartley, L. W. Murphy and Wm. E. Williams.

JOLIET, DE KALB & NORTHERN.—S. Soule, Gen. Man., Joliet, Ill., writes us that this railway is projected to run from Joliet, Ill., west, to Plattville, and thence, either northwest through Plano to De Kalb, Ill., or west to Newark, and thence north through Millington, or Sandwich to De Kalb, Ill. The length of the road will be about 75 miles, and the route is through a fine farming country. The grades and curves will be easy. There will be one large bridge over the Fox River. All but about ten miles of the right of way has been obtained. The principal business of the road will be in grain, live stock, agricultural implements, iron and steel, and their products. Contracts for construction will be let about May 1, and it is expected to begin tracklaying by June 1. The company was chartered Feb. 11, 1892. Pres., Wm. S. Elwood, De Kalb, Ill.; Ch. Engr., S. H. Daly, Warren, Pa.

Southwest.—Existing Roads.

MISSOURI, KANSAS & TEXAS.—A press dispatch from St. Charles, Mo., states that graders' material is rapidly being shipped to that point preparatory to pushing work on the extension from Booneville to St. Louis, Mo.

KANSAS CITY, WATKINS & GULF.—About 125 men are now at work on the extension to Alexandria, La. About 33 miles of track have been laid this year.

Projects and Surveys.

DARDANELLE & MT. NEBO.—This company has been chartered in Arkansas, to build the proposed railway and incline from Dardanelle, Ark., to the summit of Mt. Nebo. It is stated that the contract for clearing the right of way, grading and bridging has been let to Theo. Hartman and Jos. Evans, the work to be completed in 90 days. It is expected to have the line completed in July. The officers of the company are: Pres., W. J. Thompson; V.-P., Thos. Cox; Gen. Man. and Secy., C. A. Pratt, and Treas., W. H. Gee. Gus. Knoble is the Engineer in charge of the work. The headquarters are at Dardanelle, Ark.

VELASCO & BRAZOS BOTTOM.—It is stated that a company by this name will be incorporated to build a railway from Velasco to Brenham, Texas.

Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—This company has called for bids for a large amount of improvement work on the Pacific and Cascade division. It comprises the filling of 112 bridges and trestles, and is about one-half the improvements of this kind planned by the company for the coming summer and fall. Fully 200 bridges and trestles, making in all about ten miles, will be filled in before next winter. The work will be done all along the line from Portland to the Idaho division, and it is estimated that the total cost will be about $500,000.

CANADIAN PACIFIC.—This company has notified the Canadian Minister of Railways of its intention to build a second line across the Rocky Mountains, and that it will use the Crow's Nest Pass for this purpose.

GREAT NORTHERN.—Shepard, Siems & Co. have let sub-contracts for building 75 miles of the Pacific Extension, west of Spokane, Wash.

RIO GRANDE SOUTHERN.—The contract for building the branch from Hesperus, Colo., to the Coppinger mines, 2.5 miles, has been let to Levi & Moore.

SOUTHERN PACIFIC.—The branch from Crofton to Redlands, Cal., 7 miles, has been completed.

Projects and Surveys.

SAN FRANCISCO & WEST SHORE.—Chartered in California to build a railway from San Francisco to San Pedro and Half Moon Bay, a distance of 30 miles. Among the incorporators are J. W. Ellis and J. O. Jephson, of San Francisco, Cal.

SUMMIT SPRINGS & MT. PORTOLA.—Incorporated in California to build a railway from Redwood City to Summit Springs, and Mayfield, a total distance of 25 miles. The principal office will be at Summit Springs, Cal. Among the incorporators are A. S. Brackett, of San Francisco, Cal., and Edw. F. Fitzpatrick, of Redwood, Cal.

GREELEY, ST. VRAIN & DENVER.—Surveys have been begun for this proposed railway from Greeley, Colo., east, to a connection with the Burlington & Missouri River R. R.

EASTERN.—A press dispatch from Denver, Colo., says: "Robert Y. Force claims that the Colorado Eastern Ry. will now be built under the title of the Eastern Ry. as a belt line in Denver. Mr. Force says D. Moffat and Gov. Adams are interested in its construction. Warehouses are to be established at the foot of all the principal thoroughfares along Cherry Creek from Larimer to Broadway. This line will connect with all of the railways going out of the city. Freight can be transported by means of the new line from one railway to another at a cost less than the Union Pacific charges for such transportation. The talk of extending the line outside of the state limits Mr. Force pronounced nonsense."

DENVER & EL PASO.—This company has been chartered in Colorado to build the proposed short line from Trinidad, Colo., to El Paso, N. Mex., 420 miles.

PORTLAND & PACIFIC.—Chartered in Oregon by D. W. Lichtenthaler, A. C. Rowland and C. D. Lownsdale, to build a railway from Portland, Ore., to a point on the Pacific coast in Clatsop Co. The principal office will be at Portland, Ore.

ASTORIA SUBSIDY & GUARANTEE CO.—This company has been organized at Astoria, Ore., to raise the subsidy of $400,000, to secure the construction of a railway from that place to a connection with the Southern Pacific R. R., which is asked by C. W. Schofield and Geo. Goss.

EVERETT & MONTE CHRISTO.—Chartered in

Washington to build a railway from Everett, Wash., to Hartford, Wash., and the Monte Christo mining district. Gen. Man., A. A. Allen.

ELECTRIC RAILWAYS.

FONDA, N. Y.—Surveys will be made at once for the Cayadutta Electric Ry. from Fonda to Gloversville, running through Johnstown. Loops will be built around the two latter places for freight service, and 60 lb. T-rails used except through the streets. About 12 miles of track will be constructed. Everett Smith, of Schenectady, is president and W. Boardman Reed, of Schenectady, is the engineer.

PHILADELPHIA, PA.—The Railway Committee has decided to report favorably to Councils the ordinances granting permission to the Traction and People's lines to erect trolley wires along certain streets for the propulsion of their cars.

BALTIMORE, MD.—The Baltimore, Canton & Point Breeze Ry. Co. has been granted right of way through several streets for its electric railway. The Central Construction Co. has been organized to build the 12 miles of electric railway for the Central Passenger Ry. Co. There will be 20 motor cars and 12 trail cars. Mr. J. L. Blackwell is the engineer.

OAKLAND, CAL.—The Oakland, San Leandro & Haywards Electric Ry. Co. has awarded a contract to the Thomson-Houston Co. for equipment for 13 miles of road, generating plant and seven cars at $46,130. The road is to be in operation by May.

SAN FRANCISCO, CAL.—The San Francisco & West Shore Ry. Co. has been organized with a capital stock of $1,000,000 to build a line 30 miles long. H. W. Westphal, C. O. Swanberg and J. W. Ellis.

ELEVATED AND CABLE RAILWAYS.

CHICAGO, ILL.—The Chicago Union Elevated Ry. Co. has been incorporated by John Tyler, G. E. Scott and Wm. W. Bell, to build a line from a point on Franklin St. between Madison and Twelfth Sts., to the town of Cicero, with several branches. Capital stock, $17,000,000. The Metropolitan West Side Elevated Ry. Co. has been incorporated by John Worthy, Edison J. Harkness and W. W. Gurley, to build a line to Cicero, Ill. Capital stock, $15,000,000.

SAN FRANCISCO, CAL.—The Market Street Cable Co. will soon begin work for cabling its line to the park, which will do away with the use of steam motors on that line.

HIGHWAYS.

NEW YORK.—The people of Hempstead, Long Island, will vote at the spring election on the issue of bonds for $50,000 to macadamize 5 miles of road.

NEW JERSEY.—Moorestown township has voted to issue 4 1-2 per cent. bonds for $40,000 to build 10 miles of telford road.

ILLINOIS.—The State Legislature is to be petitioned to appropriate $10,000,000 for highway improvements.

BRIDGES, TUNNELS AND CANALS.

COLUMBIANA, ILL.—The Columbian Bridge Co. has been chartered in Illinois to build a bridge across the Illinois River at this place. Wm. Hook and Marcus Hook, of Jacksonville, Ill., are among the incorporators.

HAVANA, ILL.—The Havana Ry. Bridge Co. has been chartered in Illinois to build a bridge across the Illinois River at Havana. Incorporators same as for the Columbian Bridge Co.

ST. CHARLES, MO.—It is stated that surveys are being made locating the piers for the proposed highway bridge across the Missouri River at this place. The bridge will cost about $250,000. J. A. L. Waddell, Kansas City, Mo., is the engineer.

GALVESTON, TEX.—The Missouri Valley Bridge & Iron Works, of Leavenworth, Kan., have the contract for building the bridge connecting the main land with Galveston Island. The structure will cost $175,000.

WATER-WORKS.

New England.

CHESTER, N. H.—At the town meeting it was voted to accept the $200 left by will towards water- and the Moderator was instructed to appoint an investigating committee.

HOLYOKE, MASS.—An increased supply is proposed.

BARRE, MASS.—Steps to secure works are being taken.

CAMBRIDGE, MASS.—A bill has been reported in the legislature authorizing the city to issue $500,000 of additional water bonds.

FITCHBURG, MASS.—The Council has authorized the water commissioners to contract for pipes, specials and other material for the introduction of the proposed new supply from Meeting House Pond, at a cost of $100,000.

ORANGE, MASS.—The Water-Works Act has been signed by the Governor, and on March 26 the people will vote on its acceptance.

NORTH BROOKFIELD, MASS.—On March 26 the people will vote on the building of works at an estimated cost of $100,000.

EAST PROVIDENCE, R. I.—The fire district has voted to construct works in accordance with the plans of Engr. S. M. Gray, Providence, R. I., at a cost of from $200,000 to $300,000.

Middle.

ARKVILLE, N. Y.—Works are soon to be built, it is said. Geo. R. Dodds can give information.

CALEDONIA, N. Y.—There is talk of bonding the village for $15,000 works, including stand-pipe.

NEW PALTZ, N. Y.—It is said that $40,000 works are about to be built.

SILVER CREEK, N. Y.—The proposition to issue $35,000 of bonds for works has been defeated.

SOUTHAMPTON, N. Y.—Surveys for works have been made.

WALDEN, N. Y.—Fire protection works are proposed, and works for a general supply are talked of.

ILION, N. Y.—The Board of Water Commissioners has received 20 bids for the piping system and 12 for the supply system. The former ranged from $42,478 to $64,000, and the latter from $29,848 to $41,400, and there was one bid of $90,470 for the system complete.

CHRISTIANA, PA.—Right of way has been bought for a supply main for private works. The supply will be by gravity from springs to and from a reservoir. I. W. Slocum, Prest. Christiana National Bank is interested.

MONTOURSVILLE, PA.—The people have voted to build works.

MIFFLINTOWN AND PATTERSON, PA.—The Councils of these towns have granted a franchise for works. Address, J. Howard Neely, Mifflintown.

MIDDLETOWN, MD.—The Governor has signed a bill authorizing the town to build works.

Southern.

KENOVA, W. VA.—The Kenova Co. has been incorporated by J. T. Peck, Kenova; J. Walter White, Philadelphia and others, to build water-works, hotels, houses, etc. The capital stock authorized is $500,000; subscribed, $1,000; paid in $100.

RICHMOND, VA.—The "Times" thinks that a considerable expenditure for extensions or an increased use of meters is necessary, and sensibly advocates the latter course.

ATHENS, GA.—The sum recently voted for city water-works was $125,000.

BUENA VISTA, GA.—On April 15 the people will vote for or against works.

CARROLLTON, GA.—The Council has ordered a water-works election to be held April 18.

DARIEN, GA.—The people will vote on the introduction of water and lighting plants on April 11.

NEWPORT, KY.—The reconstruction of the largest of the two reservoir basins is projected at an estimated cost of $25,000.

CYNTHIANA, KY.—Address the Mayor regarding proposed city works.

FULTON, KY.—Bonds for works have been authorized by the Council.

OXFORD, MISS.—It has been estimated that works could be built for $5,000. The matter is before the council.

BAY ST. LOUIS, MISS.—A franchise has been secured by Chas. Sanger.

PORT GIBSON, MISS.—At a public meeting March 13 a franchise was approved for works to be built by the Port Gibson Water & Light Co.

NEW ORLEANS, LA.—After many weeks the ordinance allowing the company to issue $250,000 in bonds for filtration has been sent to the Mayor and approved by him.

LAKE PROVIDENCE, LA.—The Lake Providence Ice Manufacturing & Improvement Co. is thinking of building water-works.

North Central.

CLEVELAND, O.—The Board of Control will receive bids until April 13 for 11,460 ft. of 36-in. cast iron water-pipe and special castings, and for such cast iron water-pipe, 3 to 16 ins. diameter, with castings, as may be required during the current year. Separate bids will be received on the same date for building an aqueduct 6 ft. diameter, and three pump and gate wells near the Division St. pumping station. R. R. Herrick, Director of Public Works.

BRIGHTWOOD, IND.—The proposed new supply will be from Pogue's Run.

NEW ALBANY, IND.—Parties interested in the Silver Hills section wish the company to erect a 50,000-gallon stand pipe near the reservoirs.

CHARLEVOIX, MICH.—W. H. McCarthey informs us that the people have just voted $25,000 of bonds for works.

MANCELONA, MICH.—Water bonds to the amount of $15,000 are offered for sale by C. E. Temple, Grand Rapids, at 101. Bonds dated May 1, 1892; interest, 6 per cent.

METROPOLIS, ILL.—The Metropolis Water Co. has been incorporated by Geo. C. Morgan, A. M. Morgan and H. A. Gardner.

CHICAGO, ILL.—An ordinance was passed by the City Council of March 21, directing Commissioner of Public Works J. F. Aldrich, to contract for the immediate sinking of a shaft at the present outer end of the Lake View tunnel, and the placing of a crib at that point. Also the purchase was ordered of a 12,000,000 gallon pumping engine to be erected at the Lake View pumping station, on Sulzer St. Estimated cost $100,000.

MILWAUKEE, WIS.—The Board of Public Works has awarded a contract for an 8,000,000-gallon pump to the E. P. Allis Co., for $26,500; and for 75 hydrants to the Filer & Stowell Co., for $34.50 each.

Northwestern.

FREMONT, NEB.—It is proposed to add about 30,000 ft. of mains and 26 hydrants to the city works.

GRAND FORKS, N. DAK.—Cy. Engr. Russell has reported that a filter could be added to the works for $12,000.

ELDON, IA.—The town has voted for works.

GREAT FALLS, MONT.—The Great Falls Water Co. has, according to report, $200,000 of improvements under consideration, including a 10,000,000 gallon pump, a 10,000,000 gallon reservoir and new mains.

Southwestern.

LITTLE ROCK, ARK.—The company proposes to add five miles of mains and 62 hydrants, provided the city passes the desired ordinance.

CORPUS CHRISTI, TEX.—The new works, noted last week, will include pumps and a stand-pipe.

WICHITA FALLS, TEX.—Works are still projected, but they are dependent upon a flowing artesian well, also projected.

FREMONT, COLO.—John McCooch and others have secured the Barnard Creek water right at Cripple Creek and propose to introduce water.

Pacific.

CHEHALIS, WASH.—C. W. Maynard is interested in a scheme to build works.

EVERETT, WASH.—Works are being built, including a large well, 1,500,000 gallon pump, and two miles of mains.

LOWELL, WASH.—A supply will be introduced from a spring about 1 1-2 miles distant.

SPOKANE FALLS, WASH.—The Board of Public Works will advertise for bids for the construction of the dam and pumping station for the new water supply system.

GRANT'S PASS, ORE.—The Grant's Pass Water, Light & Power Co. has increased its capital stock from $30,000 to $170,000.

SACRAMENTO, CAL.—It is reported that Engr. Uren, of Dutch Flat, will make a survey for an extension of the South Yuba Co.'s ditch from a point near Gold Run, along the line of the Central Pacific R. R., the ditch eventually to supply water to Sacramento, Auburn and Colfax.

VISALIA, CAL.—The Visalia Water-Works Co. proposes to bore a new well, add a pump and extend its mains.

LOS ANGELES, CAL.—The Council's special committee to investigate the water question has reported in favor of city ownership. It recommends: That one of the plans of Cy. Engr. Dockweiler be adopted; that a proposition to issue $100,000 in bonds be submitted to the citizens; that the city proceed to build headworks, conduits and reservoirs, and pumping stations when required; and that negotiations be entered into for the purchase of the works of the two principal companies, the City and Citizens' Water Co.

Canada.

HANTSPORT, N. S.—Water Commissioners have been appointed, and the outlook for works seem favorable; estimated cost, $25,000.

ARTESIAN WELLS.

SULPHUR SPRINGS, TEX.—It is reported that $5,000 has been raised for a well.

IRRIGATION.

GILA BEND, ARIZ.—It is reported that the Gila Bend Reservoir & Irrigation Co. has contracted with A. A. Dougherty & Co., Los Angeles, Cal.; for the construction of 45 miles of canal. A dam has been built at Gila Bend at a cost of $85,000. Gov. Lewis Wolfley, Prest., J. C. Perry, Tucson, Ariz., Secy.

FORT COLLINS, COLO.—The Cache La Poudre Reservoir Co. has just been incorporated to build a 480,000,000 gallon reservoir about four miles east of Ft. Collins; incorporators, John B. Cooke, John A. Rankin and others; capital stock, $60,000. The reservoir will supplement the supply of a canal, already built.

SISKIYOU CO., CAL.—The boundaries of the proposed Big Springs & West Side Irrigation District have been fixed by the County Supervisors, Geo. D. Butler, Clerk, and an election ordered to be held at Wheatfield school house, March 26.

NEW COMPANIES.—Saratoga Ditch Co., Saratoga, Wyo.; trustees, H. M. Bennett, John Johnston and A. R. Couzens; $15,000. Norner Reservoir Supply Co. Windsor, Colo.; Directors, Harrison Taylor, Harry Haynes and others; $50,000.

SEWERS.

ANDOVER, MASS.—A committee, consisting of D. W. Carney, H. W. Clark and Albert McDonald, has been appointed to prepare plans for a system of sewerage. Appropriation, $300.

REVERE, MASS.—Bids are asked until March 28 for 8 to 18-in. sewer pipe. A. B. Curtis, Secy. of Com.

WAKEFIELD, MASS.—Dr. S. W. Abbott and W. G. Strong are members of the committee appointed to consider a system of sewerage for the town. Appropriation, $400.

EAST PROVIDENCE, R. I.—The town is asked for $18,000 for a proposed sewer extension.

BUFFALO, N. Y.—It is proposed to construct a sewer in Bailey Ave., to cost $128,000. The length is about 2 1-2 miles.

HORNELLSVILLE, N. Y.—Bids are asked until April 14 for about 20 miles of sewers. See advertisement.

NIAGARA FALLS, N. Y.—Contracts have been awarded to R. D. Young, at $21,440, and Alexander Makin, at $18,585, both of Niagara Falls. It is expected that other contracts amounting to $100,000 will be let April 4.

ROCHESTER, N. Y.—Bids are asked until April 4 for 2 1-2 miles of sewers. East Side Trunk Sewer Commission, City Hall.

TONAWANDA, N. Y.—The town has voted to issue bonds for $20,000 to complete the system.

NEW BRUNSWICK, N. J.—Plans for a system of sewers in the Lyle Brook district have been prepared by Asher Atkinson, Cy. Sur. About 71,740 ft. of 6 to 24-in. pipe will be required.

READING, PA.—At a meeting of the citizens, March 17, it was decided to recommend an appropriation of $200,000 for sewers.

ALBANY, GA.—Plans for a system of sewerage have been prepared by J. C. Chase, of Wilmington, N. C., and bonds will be issued for the construction.

MOBILE, ALA.—The annual message of Mayor J. C. Rich is devoted exclusively to the subject of sewers and water supply. He recommends that immediate action be taken toward having an expert engineer prepare plans and estimates for both improvements.

TERRE HAUTE, IND.—A contract has been awarded to Frederick Fischer at $14,540.

OTTAWA, ILL.—Bids are asked until April 5 for 6,529 cu. ft. of pipe sewers. James F. Farrell, Cy. Clk.

FREEPORT, ILL.—Bids are asked until April 4 for constructing sewers in two districts. Chas. Nieman, Mayor.

PERU, ILL.—Plans and specifications for the new system in the northeastern portion of the city have been prepared by Mr. Dawson, Cy. Engr.

EMPORIA, KAN.—Bids are asked until April 4 for 9,000 ft. of 15-in. and 8,700 ft. of 10-in. vitrified sewer pipe. H. S. Alexander, City Clerk.

PARSONS, KAN.—Plans and specifications for sewers in three blocks have been approved, and the Clerk instructed to ask bids for construction.

FREMONT, NEB.—The cost of the proposed system is estimated at $89,530. J. W. Andrews is Cy. Engr.

AUSTIN, TEX.—The City of Austin Sewerage Co. has been incorporated by C. M. Berriam, J. W. Wiggins and others; capital, $250,000.

CLEVELAND, O.—Bids are asked until March 30 for sewers in 4 streets; April 6, in 5; April 20, in 4. R. R. Herrick, Director Pub. Wks.

WINNIPEG, MAN.—The Board of Works will ask bids for sewers in 9 streets.

DENVER, COLO.—The Council has voted $30,000 to complete the proposed storm sewers.

STREETS.

BROOKLYN, N. Y.—The Board of Aldermen has voted to repave Atlantic Ave. with granite blocks, at a cost of $235,000.

BUFFALO, N.Y.—The committe on streets has reported in favor of paving 3 streets with Barber asphalt, 2 with rock asphalt, 2 with Syracuse vitrified brick, and 1 with Medina sandstone. The Barber Asphalt Paving Co. has been awarded three contracts, aggregating $35,093.

NEW YORK, N. Y.—Bids are asked until March 31 for furnishing and delivering cut stone at the old reservoir, Central Park; also, for paving with asphalt on present pavements, on macadam, 1 street; stone block, 2 streets; concrete, 3 streets; for paving with granite blocks, 4 streets; same with concrete foundation, 5 streets; for paving with macadam, 1 street.

EAST ORANGE, N. J.—The Clerk is authorized to asks bids for macadamizing North Maple Ave.

PHILADELPHIA, PA.—The Mack Paving Co. has been incorporated by John M. Mack, James M. Mack and Joseph P. Mack; capital, $100,000.

PITTSBURG, PA.—The Wadsworth Stone & Paving Co. has been incorporated by D. C. Bower and H. S. Wadsworth, of New London, O., and E. C. Weaver, of Wilkinsburg; capital, $10,000.

BALTIMORE, MD.—The Mayor has signed the ordinance for paving Calvert St. with sheet asphalt.

ALEXANDRIA, VA.—It is proposed to pave all the new streets.

CINCINNATI, O.—The contract for macadamizing Riddle road has been awarded to G. J. Birnbaum, at $29,400.

CLEVELAND, O.—Bids are asked until April 13 for six paving contracts with Medina stone. R. R. Herrick, Director Pub. Wks.

COLUMBUS, O.—Bids are asked until April 4 for paving Goodale St. with asphalt, stone block, Hayden block, Halwood block or brick, with 95-in. curb of Berea or Fulton stone. F. M. Senter, Clerk Bd. Pub. Wks.

PIQUA, O.—Bids are asked until April 5 for paving the Public Square with brick. J. H. Hatch, Cy. Clk.

TERRE HAUTE, IND.—Bids are asked until April 18 for brick sidewalks. C. H. Goodwin, Cy. Clk.

OTTAWA, ILL.—Bids are asked until April 5 for 46,031 sq. yds. of double layer brick paving, and 16,278 lin. ft. of sandstone curbing. N. E. Stucker, Cy. Engr.

ST. LOUIS, MO.—The Board of Public Works asks bids until April 5 for eleven grading contracts, three including telford pavement.

CLINTON, IA.—The city desires bids until April 12 for 60,000 sq. yds. of brick paving.

DUBUQUE, IA.—Bids are asked until March 31 for about 28,000 sq. yds. of brick paving, and 7,000 lin. ft. of curbing. J. C. Fitzpatrick, Recorder.

OMAHA, NEB.—About $300,000 will be spent for paving this year.

DENVER, COLO.—Bids are asked until April 18 for paving several streets with asphalt.

ELECTRICAL.

BROOKLYN, N. Y.—Bids for street lighting on the same terms as at present have been opened: arc lights, 50 cts. each per night; incandescent lights, 25 c. p., 10 cts. each; 32 c. p., 12 3-4 cts.; 50 c. p., 20 cts.; 65 c. p., 23 cts.; 75 c. p., 25 cts.

HOLLEY, N. Y.—The Village Trustees are authorized to make a contract for street lighting for three years as soon as the present contract expires.

WESTFIELD, N. Y.—The town has voted in favor of a municipal plant.

AUGUSTA, GA.—The Augusta Electric Light Co. has been awarded a contract for 250 arc lights of 2,000 c. p., for five years, at $72 per lamp per year.

CINCINNATI, O.—Bids are asked until April 12 for street lighting for eleven years. Edwin Henderson, City Clerk.

BELLEFONTAINE, O.—The citizens will vote on the issuance of bonds for $30,000 for the erection of an electric light plant.

DUNDEE, MICH.—The Dundee Electric Light Co. has been granted a franchise and will furnish 16 arc lights at $90 each per year.

HOMER, MICH.—The town has voted in favor of electric lights.

CARLYLE, ILL.—The city will soon ask bids for electric street lighting.

APPLETON, WIS.—The Clerk of the Common Council has been directed to ask bids for a plant of 150 lamps.

FOND DU LAC, WIS.—An electric light franchise has been granted to W. G. Curtis and F. B. Hoskins.

ST. PETER, MINN.—The Council has contracted with the Thomson-Houston Co. for a plant of 50 arc and 1,000 incandescent lights, for $13,700.

LACHINE, QUE.—Bids are asked until April 1 for one 50 arc light dynamo of 1,200 c. p., one 650 incandescent dynamo of 16 c. p., 100 HP. Corliss condensing engine, 100 HP. high speed engine, and 100 HP. steel boiler. H. Robert, Secretary.

NEW COMPANIES.—Ridgway Electric Light Co., Ridgway, Pa.; $10,000; Treasurer, E. C. Ross. Tower Electric Light & Telephone Co., Duluth, Minn., $60,000; G. H. Claypool, A. C. Batchelor and E. C. Jones. Omro Electric Light & Power Co., Omro, Wis.; $5,000; C. S. Douty, Frank Dennis and W. W. Race. Electric Launch & Navigation Co., Camden, N. J.; $300,000; J. Parker, of Philadelphia, and J. H. Holloway, of Camden. Electric Construction & Supply Co., Jersey City, N. J.; $225,000; Fred. A. Kinsman, of Arlington, and R. B. Ward of New York city. Electric Piano Co., Newark, N. J.; $300,000; Julius Stahl, Ludwig Schiff and Jacob Schoenbaar. Elmira Municipal Improvement Co., Passaic, N. J.; $1,000,000; F. H. Mollenhauer, of Jersey City, H. S. Roll, of Hoboken, and D. C. Robinson, of Elmira, N. Y.

CONTRACT PRICES.

CEMENT.—Washington, D. C.—The contract for cement for the Congressional Library has been awarded to J. H. McGill, of Washington, at $1.14 in bbls., or 97 cts. in bags.

SEWERS.—Brooklyn, N. Y.—The lowest bids for sewers in two streets were as follows: Harris & Maguire, 9-in. cement pipe, $1.10 per lin. ft.; 12-in., $1.40; manholes, $35 each; Edward Gorman, 12-in cement pipe, $1.10; 15-in., $1.40; street basins, $90; manholes, $35.

Greenville, S. C.—The following contracts have been awarded: Greenville Coal & Builders' Supply Co., cement, $1.60 per bbl.; Ormond & Goforth, of Yorkville, S. C., excavation, 30 cts. per cu. yd. for earth, 50 cts. and $1 for soft and hard rock; P. Bannon, of Louisville, Ky., pipe, 8-in., 10 cts. per lin. ft. and Y's at 40 cts. each; 10-in., 16 and 50 cts.; 12-in., 20 and 90 cts.; 18-in. 34 cts., $1.25; 20-in., 57 cts., $2; 6-in. plugs for Y openings, 1 ct. each.

BRICK PAVING.—Kenosha, Wis.—The Council has awarded the contract for 9,300 yds. of vitrified brick paving to J. P. Smith & Co., of Chicago, at $1.66 per sq. yd.

Franklin, Pa.—The paving contract has been awarded to R. A. Bigley at 42 cts. per sq. yd. for work, and from 28 to 43 cts. per lin. ft. for curbing, according to material. The brick will be furnished by the Franklin Paving Brick Co., at $10 per M., delivered, equivalent to 57 cts. per sq. yd.

Pittsfield, Mass.—The contract for sewer brick has been awarded to the Brookfield Brick Co. at $7.60 per M.

PAVING MATERIAL.—Baltimore, Md.—The following bids have been received for repaving Broadway: I. S. Filbert, Trinidad Lake asphalt, $2.70 per sq. yd.; Belgian blocks, $2.70 per sq. yd.; circles, $3.78; 6-in. curbing delivered and set, $1.30 per lin. ft.; Wm. A. Gault, Belgian blocks, $70 per M.; curbing $1 and $1.05 per lin. ft.; Wm. F. Weller, blocks, $75.50; curbing, $1.27; Ben. Kepner, blocks, $65; curbing, $1.60; Rockport Granite Co., blocks, $67; C. S. Rogers, blocks, $67. The contract for asphalt was awarded to I. S. Filbert, and that for blocks to the Rockford Granite Co.

PAVING.—Easton, Pa.—The bids of M. Miles & Son have been recommended for acceptance for regrading and macadamizing two streets, at 31 and 53 cts. per sq. yd.; resetting cobblestone paving, 35 cts. per sq. yd.; resetting crossing stones and curbs, 10 and 13 cts. per lin. ft., respectively. The other paving bids were from $2.20 per sq. yd for vitrified brick, to $4.50 for granite blocks, on concrete or cobblestone.

PIPE AND SPECIALS.—Chicago, Ill.—The following proposals for 1,510 tons of straight cast iron water pipe and 36 tons of special castings, for use at Jackson Park, have been received by the Bureau of Construction, World's Columbian Exposition: Addyston Pipe & Steel Co., Cincinnati, O., $20.24 per ton of 2,000 lbs. for pipe, and $38 per ton of 2,000 lbs. for castings; Radford Pipe & Foundry Co., Cincinnati, O., $20.00 and $39.50; Detroit Pipe & Foundry Co., Detroit, Mich., $21 and $40; Rhoades & Ramsey Co., Chicago, $20.95 and $45; Dennis Long & Co., Louisville, Ky., $22.74 and $49; J. H. Bass, Chicago, $45 for castings. The contract was awarded to the Addyston Pipe & Steel Co.

Romeo, Mich.—The Water Commissioners have awarded contracts for supplies as follows: Lake Shore Pipe & Foundry Co., Cleveland, pipe, $20.78 per ton; specials, 2 cts. per lb.; Snyder & Williams, Dayton, pipe laying, 10-in., 23 cts. per lin. ft.; 8-in., 17 1-2 cts.; 6-in., 15 cts.; 4-in., 12 1-2 cts.; R. D. Wood & Co., Detroit, hydrants, $25 each; James Flowers, Bros. & Co., Detroit, valves, 10-in., $24.50; 8-in., $18; 6-in., $11.50; 4-in., $7.50; Hughes Steam Pump Co., Cleveland, pumps, boilers and machinery, $4,030.

MISCELLANEOUS.

DREDGING.—Baltimore, Md.—The Mayor has signed the ordinance appropriating $15,000 to dredge Jones Falls. Bids are asked until April 1 for dredging and removal of a portion of Foley's Wharf, Lazaretto Point; also for building a wooden bulkhead at same place. F. C. Latrobe, Mayor.

Washington, D. C.—Bids are asked until April 15 for dredging at Washington Navy Yard. N. H. Farquhar, Chief of Bureau of Yards and Docks, Navy Yard.

Crescent City, Ill.—Bids are asked until April 1 for about 7 miles of ditch. J. W. Nightingale, Comr.

DREDGING.—Superior, Wis.—The Board of Public Works estimated the approximate cost of the proposed dredging at about $51,000.

GAS.—Brooklyn, N. Y.—Bids for street lighting on the same terms as at present have been opened. The gas lamps cost $20 each a year, save in the territory of the Brooklyn Gas Light Co., $19.80, and the price for public buildings is $1.25 per 1,000 cu. ft.

Western Harris Gas Co., Chicago; $10,000,000; G. W. Holdridge, G. W. Loomis and Clarke Gafen. San Francisco Gas Light & Purifying Co., San Francisco; $1,000,000; Julius Wiesender, J. W. Davis and J. F. Holling.

GAS.—Wakefield, Mass.—The Committee on Lights recommends that the town contract with the Globe Gaslight Co., of Boston, for 100 or more lights at 6 1-4 cts. each per night, the lights to burn all night.

Mechanicsburg, Pa.—The Mechanicsburg Gas & Water Co. invites correspondence with a view to improving the plant. A. Z. Myers, Secretary.

BONDS.—Duluth, Minn.—The city will sell, March 28, $200,000 of 6 per cent. permanent improvement certificates, and $200,000 of 7 per cent. city orders. N. F. Hugo, Chn. Finance Committee.

GRADING.—A large amount of grading and sewering is to be done at Granite, Mo., 5 miles from St. Louis, for the purpose of building a manufacturing town, with streets, sewers, water supply, gas, and a railway to connect with the Merchants' Bridge. Calculations are now being made of the total amount of grading and average haul, and bids will soon be advertised for. Work is to be commenced between April 15 and May 1. The work is under the charge of Pitzman's Company of Surveyors and Engineers, St. Louis.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 6 compound engines for Brazil, and 1 compound street railway motors for a Chicago line. The Rhode Island Locomotive Works, Providence, R. I., have an order for 25 freight and 22 passenger engines for the Wabash. The Brooks Locomotive Works, Dunkirk, N. Y., have shipped 2 engines to Brazil. The Rogers Locomotive & Machine Works, Paterson, N. J., have an order from the Illinois Central for 24 mogul, 15 consolidation and 3 eight-wheel engines.

CARS.—The Lebanon Mfg. Co., Lebanon, Pa., is building 150 box cars for the Long Island. Harlan & Hollingsworth, Wilmington, Del., have an order for 25 passenger cars for the Illinois Central. The Gilbert Car Mfg. Co., Troy, N. Y., has an order for 12 electric cars for the Troy City Ry. The Brownell Car Co., St. Louis, has a contract for 50 cars for the Baltimore Traction Co. The Carlisle Mfg. Co., Carlisle, Pa., is building 300 double-hopper gondola cars for the Monongahela Valley. The J. G. Brill Co., Philadelphia, Pa., has an order for 100 open cars, and 80 closed cars for the Chicago City Ry. The Northern Pacific will build 200 palace stock cars at the shops at Edison, Wash., described in our issue of Feb. 20.

CAR WHEELS.—The American Foundry Co., Tacoma, Wash., has an order for 1,700 cast iron car wheels for the Northern Pacific stock cars noted above.

THE SCHOEN MFG. CO., Pittsburg, Pa., will enlarge its plant for the manufacture of pressed steel works, and will build several new shops. A large business in brakebeams is reported. Mr. John S. Patterson, formerly Superintendent of Motive Power of the Cleveland, Cincinnati, Chicago & St. Louis, is the company's representative at Chicago, and Mr. F. J. Hickey is representative at St. Paul.

STREET RAILWAY TRACK.—The American Street Railway Track Co. has been incorporated under the laws of New Jersey, and has purchased from Mr. R. T. White, of New York and Boston, all his patents on street railway track material, and on cable and electric railways (Eng. News, June 20, 1891). Pres., Gen. E. S. Greeley, of E. S. Greeley & Co., New York; Treas., S. R. Bertram; Gen. Man., S. D. Nye. Capital stock, $300,000. The company will have an office in the Mills Building, New York. Mr. White will retain his office in the same building, and will devote his time to the development of his other patents and to building and equipping electric railways, of which he reports several on hand.

THE HUGHES STEAM PUMP CO., Cleveland, O., has orders for boilers and compound pumping engines for Romeo, Mich., and St. Joseph, Mich.; also pumps South Haven, Mich. A good business is reported.

THE UNION WIRE-ROPE TRAMWAY CO., New York, has lately constructed a double rope cableway for the Howland Falls Pulp Co., Howland, Me.; a coke handling plant for the Austral Otis Co., Australia; a double rope cableway for Clinton Stephens, Tilly Foster, N. Y.; and a twin cableway across the Youghiogheney River near Dawson, Pa., for transporting 600 tons of coal daily from mines to coke ovens. The Company has now under construction a gravity plane 6,000 ft. long for the Glasgow Development Co., of Virginia; a power incline 3,700 ft. long for the Orange Cable Co., and has received orders for four cable lines for phosphate mining companies at Anthony, Fla., and two wire rope skidders for lumber companies in Louisiana.

THE HYDRAULIC TUBE WELL CONSTRUCTION CO., of New York, has been dissolved by mutual consent of the firm, F. W. Miller, Joseph Edwards and F. R. Johnson.

M. RINEY & CO., Chicago, Ill., have opened an office in the Commerce Building for a general contracting business for the erection of bridges, buildings, viaducts, etc. The members of the firm are M. Riney and D. C. Leary, who have had 25 years experience in this line of work.

NEW COMPANIES.—Anti Smoke Pneumatic & Power Co., Chicago, Ill., $10,000,000; W. Chalmers, Andrew Onderdonk and Francis Beidler, Wilkesbarre & Hudson River Improvement Co., Jersey City, N. J., $3,000,000; to build and equip railways; C. H. Luddington and E. C. Henderson, of New York. Dearborn Construction Co., Chicago, Ill., $300,000; P. De Graff, F. G. Brewer and John T. Wentworth. Courtwright Hydraulic Machine Co., Chicago, Ill., $250,000; C. G. Davis, J. E. Hamilton and F. E. Turner.

CURRENT PRICE LIST.

RAILS.—New York: $30 at eastern mills; old rails, $20 to $20.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $21.65 for iron and $16.25 to $17 for steel. Chicago: $31.50 to $32; old rails, $19 for iron and $13.50 to $14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 2 to 2.05 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagonal nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.15 to 2.2 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57 1-2 and 47 1-2 per cent. on black and galvanized butt-welded; 67 1-2 and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $16. Pittsburg: $14 to $15. Chicago: $13.50 to $15.50.

LEAD.—New York: 4.15 to 4.2 cts. Chicago: 3.97 to 4 cts. St. Louis: 3.9 to 3.92 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.8 to 1.95 cts. for tank, 2.1 to 2.3 cts. for shell, 2.4 to 2.65 cts for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.15 to 2.3 cts.; channels, 2.15 to 2.3 cts.; angles, 1.9 to 1.95 cts.; tees, 2.5 cts.; universal iron mill plates, 1.9 to 2 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined iron and steel bars, 1.75 cts.; steel plates, 1.9 to 1.95 cts. for tank, 2.15 cts. for shell, 2.25 to 2.3 cts. for flange, 3.75 to 4.15 cts. for firebox. Chicago: beams, 2.25 to 2.5 cts. for standard, 2.37 cts. for small, and 2.7 cts. for 20-in.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.5 cts.; universal plates, 1.9 to 2 cts.; sheared steel plates, 1.95 to 2 cts.; steel plates, 2.4 to 2.5 cts. for tank, 2.65 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.

WANTED.—Engineering News for March 15, Oct. 11, 1884. Will give twenty cents each. Must be in good condition. W. H. L., care Eng. News.

WANTED.—Two steam road roller engines, one locomotive engineer, two foremen for Meadam road work. WM. C. CASWELL, Clifton, Staten Island. 14-1t

WANTED.—Seven (7) miles of 50-lb. or 60-lb. T rails, for which we will give first mortgage 6 per cent. bonds. They will be the only first mortgage bonds on the road. References. Address O. K., care Engineering News. 14-1t

WANTED.—Ex-chief engineer, Yale graduate, who understands Spanish and has had 18 years' experience in United States, state, municipal and railway engineering work, and with credentials of the highest character, solicits correspondence with a view to an engagement. Address "X.," Engineering News. 4-15t

WANTED.—Graduate Civil Engineer, engaged several years at drafting, figuring and designing all kinds iron structures and bridge work, and who has been engaged in contracting all over the country, desires engagement with a reliable firm. If for taking contracts exclusively money only object. Address E. B. P., No. 118 Diamond St., Pittsburg, Pa. 9-6t

WANTED.—Roadmaster and graduate engineer, good manager and disciplinarian, thoroughly acquainted with the best practice, wishes to change location. At present with large trunk line. Wishes position as engineer maintenance of way or supervisor. Best references. Address R. R., Engineering News. 10-8t

WANTED—Position by civil engineer, age 35, good instrument man, topographer and draftsman, with experience in the design and construction of sewerage, water works, roads, harbor improvements, foundations and heavy masonry. Best references. Address STADIA, care Engineering News. 10-6t

WANTED—A position as rodman or chainman; am a fair leveler. Best of reference, will go anywhere. I want steady work, not large pay. Address W. H. CHRISTIE, Van Ettenville, N. Y. 10-6t.

WANTED—Engineering News for Jan. 7, Apr. 15, 1882; Dec. 29, 1883; May 30, 1885; Jan. 11, Mar. 15, 1890. Will pay 15 cents a copy. Put name on wrapper when sending papers.

WANTED—Bridge engineer, with 11 years experience, wants position. Perfectly familiar with making shop drawings, as well as estimates on all kinds of bridge and roof work. Address BRIDGE, care Engineering News. 11-3t

To the advertiser "Bridge:"—There are letters from prominent bridge manufatcurers and one telegram received on Thursday from Minneapolis enacting you.—Engineering News.

WANTED—Position by civil engineer as transitman, rodman or tapeman on railroad or city work, or as assistant in any surveying or engineering work. College education; age, 23. Address H. I. S., Box 160, Frankfort, Ross Co., O. 7-6t

WATER FRANCHISE WANTED.

Town not smaller than 2,500; will pay fair price for a franchise that is right where town is promising. Give full particulars. Address "WELDON," care Engineering News. 12-4t

WANTED—Position as assistant superintendent or manager in or near New York; large experience in marine work, steam and hydraulic engineering, 6 years' shop and 10 years' office experience. Has had charge of office before. In good position now. Has been in position in Scotland and Germany. Best references. Address H. K., care ENGINEERING NEWS. 12 6t

WANTED—A steady position as locomotive engineer on some new road. Single; age, 23; three years' practical experience in railroad work; familiar with air and vacuum brakes; graduate of Mech. Engr. Dept. of Minn. State University; good mechanical draftsman and willing to go anywhere in United States. Address A. H. A., 68 Summit Ave., St. Paul, Minn. 12-6t

WANTED—A position as foreman of granite yard, quarry or masonry work; 15 years' experience; reference furnished if desired. Address J. MORRISON, 87 Oak St., Lawrence, Mass. 12-3t

WANTED—Position as agent by an English mechanical and C. E. (resident this side six years) for manufacturer either at New York or Boston, or as manager or salesman. Address J. C. X., Box 672 New York City. 12 3t

WANTED.—A graduate of civil engineering from Yale desires a position in the East or South; has had considerable experience on preliminary, location and construction as rodman, levelman and transitman; at present with one of the large Western trunk lines. Address, E. F. M., care Engineering News. 12 3t

WANTED—Copies of Engineering News for Sept. 27, Oct. 4, and Nov. 29, 1890. Will pay 25 cts. apiece for them. Must be in first class condition. Address this office.

CITY ENGINEERS

who contemplate increasing their Engineering Force are invited to send us description of men wanted.

No charge to Employers.

Engineering Employment Bureau,

8 GRANGER BLOCK, SYRACUSE, N. Y.

WANTED.—A young graduate civil engineer, experienced in railroad work, is open to engagement. Is a good draftsman and instrument man, and has had experience in designing masonry work, trestles, etc. Disengaged April 1. Address L. M., care Engineering News. 12 3t

WANTED—By an experienced resident engineer, now so employed, a position as resident or division engineer, South or Southwestern states preferred. One month's previous notice required. References, instruments, etc. Address H. F. (this office). 12-6t New York City.

WANTED—A first class city engineer and "all around surveyor" would like to locate in a growing town where a good practice could be assured, or would engage with a real estate syndicate. References. Address "EXPERIENCE." Engineering News Office, 12-6t New York City.

WANTED.—Surveyor (32), experienced in office and field work (land, city, topographical, hydrographic, mining), wants situation within or without the States; speaks Spanish; no objection to any climate. Address B. KARGER, 1416 Church St., San Francisco, Cal. 13 3t

TEMPLATE MAKER—Wants situation as foreman of template shop, or would work as journeyman in first class shop. Can give reference. Address J. P. BENNETT, No. 5623 Tracey Ave., Englewood, Ill. 13-3t

WANTED.—To Private Engineers and Surveyors—Young engineer of practical experience in masonry and wood work designing, mapping, etc., good field and office man, wishes to associate himself with engineer, with view to becoming partner or buying the business, if satisfactory. Address T., care Engineering News.

WANTED—By young man possessing executive ability, position as instrumentalist or as foreman or superintendent by contractor. References, last employer and others. Address BOX No. 76, Holbrook, Mass. 13-3t

WANTED—A young engineer who graduates in June, but is open to engagement April 1, desires any position in field or office. Six months' field experience. Will go anywhere. Address L. ZEARLEY, Morgantown, W. Va. 13-3t

WANTED—Position by a civil engineer and A1 topographical and mechanical draftsman. EUROPEAN GRADUATE, P. O. Box 25, Drifton, Pa. 13-3t

WANTED—Indices to volumes 17, 22, 24; will give 10 cents each for them.

MR. K. HELLENTHAL, whose address is New York City, is requested to call at the P. O. in N. Y. for mail addressed to him, signed The Columbus Bridge Co. 13-2t

WANTED—A situation as general office man and draftsman in either city or rail way engineer's office. Twenty years' experience in civil engineering. References if required. Box 185 Brooklyn, N. Y. 13-3t

WANTED—Immediately, draftsman; two experienced men to trace for photolithography; expert letterers.

JULIUS BIEN & CO.,
13-1t 139 Duane St., City.

WANTED.—A civil engineer, 12 years' experience in R.R. location and construction and municipal engineering, desires position; at liberty about April 5, 1892; first class references. Address DENSTON, care Engineering News, Tribune Building, New York City. 13-3t

WANTED—One or two competent draftsmen on shop detail work; best of references required; state experience and salary expected. Apply to J. R. WORCESTER, Chf. Engr. Boston Bridge Works, East Cambridge, Mass. 13 1t

WANTED—Correspondence with good party, practical paving brick man, one who understands making of the same and has some capital to invest either one-third or one half expense of building works and to act as partner. Address B. B., care EngineeringNews. 13-2t

WANTED—A young engineer of technical education, with some experience on structural iron work. Must be accurate in work and strictly temperate. Address DETAILS, Engineering News. 13-2t

WANTED—Position by young engineer. Two years' experience in city and railway engineering; good draftsman. Formerly in U. S. Engineering Department; small salary. Address J. A. KELLEY, No. 130 West Newell St., Syracuse, N. Y. 13-3t

WANTED—Situation by a good draftsman experienced in bridge construction, architectural iron and ornamental work. Independent designer. Address A. V., 137 W. 9th St., Cincinnati, O. 13-3t

WANTED—Engineering News for Aug. 1, 1885. Will pay twenty cents a copy. VAN, care Engineering News.

For Sale.

Two Baldwin Locomotives, nearly new, standard gage, saddle tank, 28 and 32 tons respectively. Also one geared standard gage locomotive, 14 tons; 60 four-wheeled five yards capacity dump cars in good repair; 1 Thompson Steam Shovel; 1 Souther Steam Shovel, in good condition; about a mile and one-half second hand 50-lb. iron. Apply, SAN FRANCISCO BRIDGE CO., 42 Market St., S. F. 6 8t

FOR SALE—12 vols. Engineering News, in half morocco binding; complete and unmarked, 1886 to 1891 inclusive. What is offered for the lot? Address P. O. BOX 85, Kansas City, Mo. 12- t.

For Sale.

Derrick Barge, 40 ft. by 80 ft., with 80 ft. mast and 60 ft. boom. First class condition. Will hoist 15 tons. Address

McCORMICK CONSTRUCTION CO.,
12-tf No. 904 Olive St., St. Louis, Mo.

FOR SALE—One 16-HP. "Mundy" double engine, double drum hoisting engine, as good as new; only used ten days. Address M. FARGUSSON, Southport, N. C. 13 tf

FOR SALE.

A size "F" 45 in. diameter Collian cupola. Has never been used, and is now ready to deliver complete with firebrick lining. Base, frame, etc., all ready for use. Will make a very low figure. Address THE CONGDON BRAKE SHOE CO., 518 Phenix Building, Chicago, Ill. 13-2t

FOR SALE—Transit, made by Stackpole Bros. in 1891. Graduated to 30 seconds. Has vertical circle, stadia wires and movable center. But little used and as good as new. Address ENGINEER, care Letter Carrier 103, Boston, Mass. 14—2t.

SECOND HAND—FOR SALE.

Four Lidgerwood; 3 Mundy hoisting engines; 3 pile drivers, with hammers complete; 3 steam dredgers; 3 steam shovels; 3 narrow-gage locomotives; cars; rails; Carson Trench digger; pumps, all sizes up to 4,000,000 gallons; boilers—condensers, compressors; pipe, all sizes; tanks, all sizes; road scrapers; road rollers; crushers; engines, all sizes; centrifugal pumps; contractors' tools. W. S. MIDDLETON, 25 John St.

For Sale.

Transit, level, leveling-rod, surveyors' compass, pocket compass, slope level, Locke hand level, engineer's chain, surveyor's chain, Engineering News, complete and broken sets from 1878 to date; Latham's Sanitary Engineering, Trautwine on Excavations and Embankments, Trautwine's Engineer's Pocket-book, Shunk's Field Engineer, Cleeman's Railroad Engineer's Practice, Roper's Engineer's Handbook, Weale's Civil Engineering, Fanning's Treatise on Hydraulics and Water Supply, Eubank's Hydraulics and Mechanics, Gummere's Surveying, Geological Survey of Wisconsin, Iowa and Minnesota, (David Dale Owen) rare; Head of Mississippi River (Schoolcraft), Mineral Resources of United States (J. Ross Browne), Geological Survey of Iowa and Minnesota (David Dale Owen), Geological Survey of Wyoming (Hayden), Atlas of Colorado (Hayden), valuable; Manual of Geology (Dana). Communicate with J. OPPERMAN, 52 Telephone Building, St. Louis, Mo. 14—

Business Opportunity.

A controlling or partial interest in a prosperous heavy boiler, tank and plate work manufacturing business located at Chicago. Total investment about $100,000; more economically and eligibly located than any of its competitors. The largest and most complete plant in heavy tools in the West. In perfect order. Shops are crowded with profitable orders. Growing business. No limit to the field. reason of selling, illness of principal officer. An excellent opportunity to get into a well established and growing business. Most thorough examination invited. Address

HIGH GRADE BOILER,
Care of McMURDY & JOB, Attorneys,
Chamber of Commerce Building,
13-4t Chicago, Ill.

LABOR.

JOSEPH BRUNO, *Contractor.*

Italian laborers supplied and work superintended. Address 15 London St., East Boston, Mass.

ANY CONTRACTOR

Or company needing laborers address M. MEOLA, Box 54, Wheeling, W. Va.

CHARLES P. MARTINO.

Italian laborers supplied for railroads, waterworks, etc. Address 242 N. 5th St., Brooklyn, E. D., N. Y.

Notice to Sewer Contractors.

Sealed proposals indorsed "Proposals for Building Sections 4 or 5 of the Newton Sewer System" will be received at the office of the City Engineer, City Hall, West Newton, Mass., until Tuesday, April 19, 1892, at 12 o'clock M; the award of the contract, if awarded, will be made by the Joint Standing Committee on Sewers as soon thereafter as practicable. All proposals must be on the blank form furnished by said Committee and must be accompanied by a certified check upon a national bank of the cities of Newton or Boston drawn and made payable to the order of the Treasurer of the city of Newton for $500.

Some of the approximate quantities for the sections are as follows:

	Section 4.	Section 5.
24-in. by 36-in. brick sewer	4,250	....
24-in. pipe sewer	2,700	....
20-in. " "	....	5,650
18-in. " "	1,350	1,400
15-in. " "	....	2,150
12 in. " "	....	1,120
10-in. " "	10,100	3,050
8-in. " "	26,000	21,000
6 in. " "	5,700	5,200
Cu. yds. of brick masonry	1,500	550
Cu. yds. of material to be excavated at various depths	54,000	53,500

Plans can be seen and specifications and forms of contract can be obtained at the office of the City Engineer.

Each bidder is required to make a statement indicating what sewer work he has done, and to give references that will enable the committee to judge of his business standing, and no bid will be received in case the bidder has not looked the work over on the ground.

The Committee reserve the right to reject any and all bids, and they also reserve the right to award but one section to a bidder if they shall deem it to the interests of the City of Newton so to do.

WILLIAM F. HARBACH,
EDWARD B. WILSON,
ERASTUS MOULTON,
GEORGE S. DOWNS,
CHARLES W. KNAPP,
Joint Standing Committee on Sewers.

City Hall, West Newton, Mass., March 29, 1892.

ALBERT F. NOYES, City Engineer.
14-2t

Notice.

To Dealers in Portland and American Cement and Poundrymen.

Sealed proposals for furnishing about 8,000 barrels of Portland cement, and about 1,000 barrels of American cement, and 400 cast iron manhole covers, will be received at the office of the City Engineer, City Hall, West Newton, Mass., until Tuesday, April 19, 1892, at 12 o'clock, M.; the award of the contract, if awarded, will be made by the Joint Standing Committee on Sewers as soon thereafter as practicable. All proposals must be on a blank form furnished by said committee, and must be accompanied by a certified check upon a national Bank of the cities of Newton or Boston, drawn and made payable to the order of the Treasurer of the city of Newton for $200.

Specifications and forms of contract can be obtained at the office of the City Engineer.

The committee reserve the right to reject any and all bids, if they shall deem it to the interests of the city of Newton so to do.

WILLIAM F. HARBACH,
EDWARD B. WILSON,
ERASTUS MOULTON,
GEORGE S. DOWNS,
CHARLES W. KNAPP,
Joint Standing Committee on Sewers.
ALBERT F. NOYES, City Engineer.
City Hall, West Newton, Mass. 14-3t.

R. D. WOOD & CO.

Engineers, Iron Founders, Machinists, 400 CHESTNUT STREET, PHILADELPHIA, PA.

CONSTRUCTORS OF GAS AND WATER WORKS.

MANUFACTURERS OF ALL KINDS AND SIZES OF CAST IRON PIPE.

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